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D R A F T:

ENVIRONMENTAL IMPACT STATEMENT FOR THE AIR POLLUTION VARIANCE

REQUESTED BY:

THE ANACONDA ALUMINUM COMPANY FOR ITS ALUMINUM REDUCTION PLANT
AT COLUMBIA FALLS, MONTANA

February 7, 1974

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FOREWORD

This statement has been prepared by the Environmental Sciences Division of the State Department of Health and Environmental Sciences, pursuant to the Montana Environmental Policy Act, (MEPA) Section 69-6504 (b)(3).

The MEPA requires preparation of an environmental impact statement whenever a state agency is considering some action that could result in a significant impact on the environment. The action contemplated in this case is a decision regarding an application for an air pollution variance by Anaconda Aluminum Company for its aluminum reduction plant in Columbia Falls, Montana.

This department, with the help of other agencies and members of the public, must decide whether granting the variance would result in the continuation of emissions into the air to an extent sufficient to constitute danger to the public health and safety, and whether denial of the variance would produce hardship without equal or greater benefits to the public.

Because of the need to hold hearings as soon as possible, there will be no 15-day extension of the 30-day waiting period following issuance of this statement. All comments should be sent to Daniel Vichorek, Technical Writer, Environmental Sciences Division, Cogswell Building, Helena, Montana, 59601, no later than 30 days from the issue date.

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I. INTRODUCTION

A. Summary

The Anaconda Aluminum Company Division of The Anaconda Company has petitioned for variance from compliance with certain air pollution control requirements of the Department of Health and Environmental Sciences pertaining to fluoride emission, particulate emissions and visible emissions.

The Company has proposed certain actions in lieu of compliance, and the state is not convinced of the adequacy of the strategy. Anaconda Aluminum Company has provided no assurance of compliance, at any time and has not even demonstrated a "good faith" effort to control the emissions.

Present emissions continue to damage vegetation and subject people and animals to risk of adverse effects. The need for emission control and compliance has been clearly demonstrated.

Control technology exists and is in use today to comply with the regulations, and the cost of this control is commensurate with other plants' expenditures.

The Department therefore will recommend to the Board of Health and Environmental Sciences that the variance request be denied.

B. The Petition

The Anaconda Aluminum Company (AAC) has petitioned the State Board of Health and Environmental Sciences for exemptions from certain air pollution regulations set by the Board. The petition seeks a one year variance for the purposes of developing a new process for abating certain emissions from the Company's Columbia Falls plant. The applicable regulations are 16-2.14(1)-S1430, S1460 and S14080 of the Montana Administrative Code (MAC). The regulations respectively pertain to particulate emissions, visible emissions, and fluoride emissions. Copies of the regulations are included in Appendix A as is a copy of the variance petition.

Emissions of fluoride from the plant violate regulation S14080 Aluminum Plants, Fluoride Emissions, effective June 30, 1973. Particulate emissions also may well be in excess of the applicable standards.

AAC has installed some air pollution control equipment to collect and treat emissions from the process, but large quantities of fluorides and particulate matter escape this system and are emitted from the roofs of the buildings enclosing the process equipment. There is no pollution control equipment to treat the roof emissions from the plant.

According to the variance request, "...there seem to be only three additional air pollution control strategies which could reduce the current level of the plant's emissions." They are a conversion of the plant to a different process, installation of roof scrubbers of the type now employed elsewhere in the industry, and development of a new type scrubber.

Anaconda Aluminum proposes that a variance be granted for one year to allow further study of some new type of scrubbing system. The petition contains no provisions for or predictions of compliance with the existing regulations, except at the Company's discretion as to the technical and economic suitability of the device being researched. Given the information in the petition, ten percent of the roof emissions might be treated by July of 1976 but beyond this point, a timetable for control is nonexistent and control methods are at best indefinite.

C. Variances

Variances are allowed by Section 69-3916 Revised Codes of Montana (RCM, 1947), which is summarized below.

Any person responsible for emissions subject to regulation may apply for an exemption or partial exemption from such regulations.

The Board of Health may grant the variance "if it finds that:

a) The emissions occurring or proposed to occur do not constitute a danger to public health or safety; and

b) Compliance with the rules or regulations from which exemption if sought would produce hardship without equal or greater benefits to the public."

No variances may be granted without a public hearing and without consideration of the interests of all parties concerned or affected.

No variance shall be granted for more than one (1) year except that an exemption may be renewed for like periods.

Further, a variance is not the right of an applicant but is in the discretion of the Board, and shall not prevent or limit the application of the emergency provisions of the Montana Clean Air Act.

D. MEPA

The Montana Environmental Policy Act of 1971 (MEPA) requires that a detailed statement of environmental impacts be prepared on major action of state government "significantly affecting the quality of the human environment." In the case at hand, the action by the Board of Health in regard to the variance petition will in fact constitute such an action of state government as to require an environmental impact statement (EIS).

II. DESCRIPTION OF PLANT AND PROCESS

A. Basic Manufacturing Process

Primary aluminum manufacture employs the Hall-Heroult electrolytic reduction process. Alumina ore is dissolved in a molten bath of cryolite contained in a steel crucible with a carbon lining (cathode). An electric current is then passed from a carbon block (anode) suspended above the bath through this bath to the cathode. The current reduces the alumina ore (AL_2O_3) to molten aluminum metal and oxygen, and the molten aluminum is withdrawn from the cell into large crucibles and cast in the desired forms.

The raw materials for the process are coke, pitch, cryolite, aluminum fluoride, alumina ore, and electric energy. The alumina ore is a refined form of bauxite, a naturally occurring ore of hydrous aluminum oxides and hydroxides, the major sources of which are in South America and Australia. Anaconda Aluminum's ore is shipped from Jamaica to Columbia Falls via ship and rail. Cryolite, a double fluoride salt of sodium and aluminum ($3NaF \cdot AlF_3$ or Na_3AlF_6), is used for the cell electrolyte and as solvent for alumina. Table 1 gives the composition of Anaconda Aluminum's cryolite. Alumina ore is the prime source of aluminum for the process, although the cryolite and aluminum fluoride provide some. An analysis of the alumina is given in Table 2. Aluminum fluoride is consumed in the cells and is added to maintain optimum operating conditions in the pot. See Table 3. Metallurgical and petroleum cokes are purchased and processed into anodes and cathode paste. See Table 4.

Anaconda Aluminum employs electrolytic reduction cells, or pots, of what is known as vertical-stud Soderberg design. A schematic diagram of the vertical-stud pot is shown in Figure 1. The cell itself is about 27 feet long, 14 feet wide and has a total height of approximately 15 feet. The bottom of the cell is a steel tub lined with the carbon cathodes. The top of the cathode is about at floor level; therefore, the bottom of the anode is approximately at floor level and the pot is suspended from the floor. The anode is a mixture of fresh anode paste, partially baked paste, and solid carbon suspended from vertical steel pins, or studs. The anode is surrounded by a steel casing with a gas collection skirt at the bottom for collection of the pot gases. As can

Table 1

CRYOLITE ANALYSIS

Molecular Composition	Range (%)
Silicon (Elemental)	0.2-0.35
Fe_2O_3	0.02-0.1
Cryolite (Na_3AlF_6)	90-95
CaF_2	0.04-0.06
Al_2O_3	3-5
H_2O	0.05-0.15
Elemental Composition	
Fluorine (F)	48-52
Sodium (Na)	31-34
Aluminum (Al)	13-14

Table 2

ALUMINA ANALYSIS

Molecular Composition	%
SiO_2	0.01
Na_2O	0.58
TiO_2	0.002
Fe_2O_3	0.014
H_2O	0.245
Loss on ignition	0.485
Al_2O_3 (Diff)	98.665

Table 3

ALUMINUM FLUORIDE ANALYSIS

SiO_2	0.16
Fe_2O_3	0.015
AlF_3	94.5

Table 4

PETROLEUM COKE ANALYSIS

Ash	0.47
Si	0.03
Fe	0.04
S	1.03
H_2)	0.01
Volatile	0.19

VSS SODERBERG CELL
SCHEMATIC ARRANGEMENT

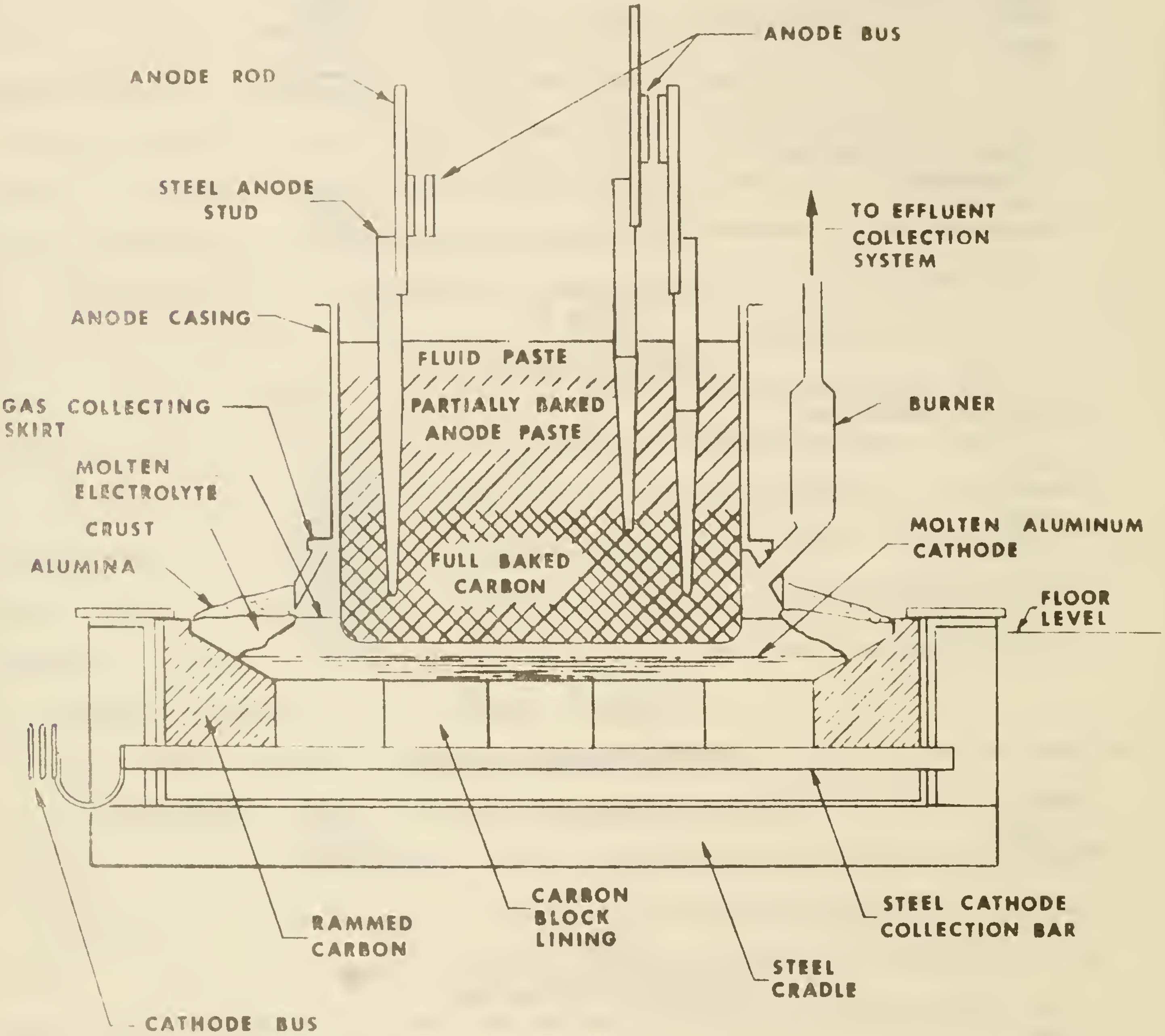

FIGURE 1

be seen in Figure 1, the skirt extends out over the molten cryolite to the frozen crust of cryolite and alumina.

Anaconda Aluminum's plant has 600 pots in 5 potlines of 120 pots each. Each line is composed of two buildings with 2 rows of 30 pots per building.

The cathodes are composed of carbon blocks laid into the steel pot bottom, "mortared" in place with cathode ramming paste. Anaconda Aluminum purchases the blocks and makes their own ramming paste. The "baked-in-place" anodes used in Soderberg cells are formed by grinding petroleum coke and mixing it with pitch, which is formed into briquettes, and transported to the potlines and eventually placed on top of the anodes.

Electrical power is supplied to the anodes by buss bars connected to the studs (see Figure 1). A collector bar in the pot bottom provides the complete electrical circuit. Current supplied to each pot averages 107,500 amperes (A) at 5.38 volts (V).

The current supplied generates large quantities of heat. The heat generated drives off the volatile hydrocarbons in the briquette, and forms a solid block of carbon, baked onto the steel pins. The heat also serves to maintain a molten bath in the cell.

Current passes from the anode to the cathode and electrolytically reduces the Al_2O_3 to aluminum and oxygen. The cell reactions are:

Bath: $Al_2O_3 \longrightarrow 2Al^{+++} + 3\ O^{--}$

Cathode: $Al^{+++} + 3\ e^{-} \longrightarrow Al$

Anode: $O^{--} \longrightarrow O + 2e^{-}$

The molten aluminum (2.3 gms/cc) is denser than the molten electrolyte (2.1 gms/cc) and sinks to the bottom of the pot. The anode is consumed as the oxygen combines with some of the carbon from the anode to form carbon monoxide and carbon dioxide. A certain amount of hydrocarbon remains in the anode, is vaporized and is partially burned. Referring to Figure 1, one can see the basic configuration of an operating pot showing layers of aluminum, bath, crust, etc. The cryolite, alumina, and aluminum fluoride are introduced by spreading them on top of the frozen crust around the cell. Periodically, the crust is broken and the raw materials are forced into the bath. This causes dusting of the ores and allows pot gases to escape. The molten bath contains various chemical forms of the raw materials.

Most efficient aluminum production is a function of several factors, many of which are limited by design. Variables in the process are largely restricted to such operation conditions as current density, current flow, bath temperature, bath ratio, and bath composition.

Current density at the Columbia Falls plant averages 4.89 A/in^2, at a total amperage of 107,500. Voltage drops are 798.16 millivolts (mV) across the anode and 445.66 mV across the cathode. Cell voltage averages 5.383 V. With the plant's 1972 production rates, total energy consumed was 3.2 billion KWH or an average of 8.49 DC kilowatt-hours per pound of aluminum (DC KWH/LB) with ranges from 8.675 DC KWH/LB to 8.373 DC KWH/LB. Total consumption is equivalent to 530,000 individual residential customers (Montana Power - 1971 average 6032 KWH/year). One recent plant with different cell type was designed to operate at 6.5 KWH/LB (1).

Anaconda Aluminum operates their pots at a bath temperature averaging 966°C with a range from 955 to 974°C. Industry-wide cells are operated from 940 to 980°C (2). Another source (3) states that normal cell operating temperature is about 975°C. Commercial bath ratios (wt. ratio of NaF to AlF_3) range from 1.10 to 1.40 (2). The pots at Columbia Falls average a bath ratio of 1.23. Bath composition--the relative amounts of the raw materials and their related compounds--is quite variable and difficult to assess. Alumina concentration, which has a decided effect on fluoride emissions, is kept within the solubility range of the electrolyte. (2-6 weight %)

Ancillary operations to the potlines are the paste plant previously mentioned, the casting area, and fabricating plant.

Table 5 gives material throughputs at the plant for 1971 (AAC data).

B. Sources and Nature of Pollution

General

Anaconda Aluminum has requested a variance from the regulations pertaining to particulate matter and fluorides as applied to the reduction plant. The total impact of the plant though, is the cumulative result of all the emissions, including sources for

TABLE 5

Materials Used at Anaconda Aluminum Company

Basis - 180368.4 tons/year Al Metal

Inputs	Tons/Year	#/Ton Al
Alumina	392,886.0	4356
AlF_3	11,536.2	128.2
Cryolite	3,766.8	41.8
Anode Paste	108,273.6	1200
Cathode Paste	1,489.6	16.5
Carbon Blocks	1,138.8	12.6
Sidewall Blocks	438.0	4.9
Electricity	3.06×10^9 KWH	16,965 KWH/Ton Al
Borax	87.6	0.97
Iron	175.2	1.94
Ferro Manganese	262.8	2.91
Ferro Phosphorus	17.5	0.19
Silicon	8.8	0.098
Lime	8,497.2	94.2
	528,605.1 TPY	
Outputs		
Aluminum	180,368.4	2000

which no variance is requested Prime pollutants from aluminum reduction plants are gaseous and particulate fluorides, aliphatic and aromatic hydrocarbons as particulate, and raw material particulate. Discussion of the environmental effects of the various pollutants is contained in Section IV.

The AAC paste plant processes cokes and coal tar pitch to anode paste and cathode paste. Emissions are generated at several points in the plant. Coke dust, primarily carbon, from the unloading and transfer facilities is collected in cyclones and baghouses. Emissions from the metallurgical coke dryer are scrubbed in a venturi scrubber installed in 1972. Pitch is used as a binder for coke to form the anode paste and cathode ramming paste. The carbon cathodes are formed by baking a metallurgical coke-pitch mixture in molds to drive off the pitch leaving a monolithic carbon block about 2 feet on a side. This process is not performed at Columbia Falls. AAC purchases its cathodes elsewhere. The Company, however, makes the cathode ramming or green paste used for assuring good electrical contact between cathode blocks, and for filling voids not suitable to the flat sided carbon blocks. With the exception of the metallurgical coke dryer, emission sources in the paste plant are intended to be controlled with baghouses. Carbonaceous dusts continue to be emitted however.

The nature and quantities of reduction cell effluents have drawn the most attention. Cell emissions consist of numerous chemical forms and considerable research has been done to identify them. The pollutants found within the cell itself are primarily hydrogen fluoride (HF) gas and particulate matter consisting of cryolite, chiolite, and aluminum fluoride. According to AAC, gaseous fluorides, principally HF constitute 90% of total F emissions. The other 10% is in particulate forms as 60% cryolite ($Na_3 AlF_6$) 20% chiolite ($Na_5 Al_3 F_{14}$) and 20% aluminum fluoride (AlF_3). The literature reveals that pot gases may contain such particulates as carbon, sodium fluoride (NaF), calcium fluoride (CaF_2) alumina, and various complexes of sodium, aluminum, calcium, fluorine. Gaseous emissions may include carbon tetrafluoride (CF_4), silicon tetrafluoride (SiF_4), carbon disulfide (CS_2), carbonyl sulfide (COS), hydrogen sulfide (H_2S) and sulfur dioxide (SO_2). The pot gases also contain large volumes of carbon monoxide and carbon dioxide from oxidation (combustion) of the sacrificial anode and some tarry hydrocarbon remaining in the anode.

The anode top is another significant source of emissions. The coal tar pitch used as anode binder contains significant quantities of aromatic hydrocarbons. As the heat from the reduction process bakes the anode in place, these aromatic hydrocarbons, along with other volatiles, are driven off into the potroom atmosphere. This process is very similar to coal carbonization in its result, and to coke manufacturing in a coke oven, wherein coal tar volatiles are driven off leaving primarily carbon. Coal tar pitch has been significantly implicated as a source of carcinogenic (cancer producing) organics (4, 5, 6).

Fluorides

Large quantities of fluorides are emitted from the cells which is not surprising when one considers that the fluoride input to the cells is about 110 pounds of F per ton of aluminum produced and aluminum is the only product (AAC data for 1971). This figure may vary from time to time. Fluorine, the most electronegative of all elements, is not found in its elemental state in pot gases as it is extremely reactive.

The factors which affect the efficiency of aluminum reduction are electrolyte conductivity, bath temperature, cryolite or bath ratio, alumina concentration, bath composition, electrode spacing, and current flux. Several of these have considerable effect on fluoride emissions, including bath temperatures, bath ratio, alumina concentration and current flux.

The amount of current supplied to a cell directly affects the production of aluminum. Oversimplified, the more current that is supplied, the more aluminum is produced. Correspondingly, as aluminum production rates are increased, fluoride evolution is also increased. Design of the cell and electrical system limit this factor to some maximum. The alumina concentration affects fluoride evolution inversely; that is, an increase in alumina concentration decreases fluoride emission (7, 8).

Bath ratio, the weight ratio of NaF to AlF_3, affects fluoride emissions inversely. Therefore, a decrease in NaF or increase in AlF_3 will decrease the bath ratio and

and increase fluoride emissions.

Fluoride emissions vary directly as bath temperature. As bath temperature increases, fluoride emissions increase. This is largely due to the increase in vapor pressure of HF.

The predominant gaseous fluoride emitted is HF which combines with water vapor to form aqueous hydrofluoric acid. Fluorides emitted as particulate can be found as gases in the pot atmosphere. Condensation and equilibrium shifts of the melt species reuslt in this phase change. The relative quantities and nature of fluoride emissions are affected by the previous parameters according to a variety of complex chemical and physical mechanisms, many of them ill-defined.

As all effluents generated are not emitted to the atmosphere at the same point, they are categorized as either primary or secondary depending on the emission point. Those emissions collected by the pot gas collection system and treated in the primary system are the primary emissions and, prior to treatment, constitute the bulk of the total pollutants generated. Those pollutants escaping the collection system through the crust and those hydrocarbons from the anode top, whether treated or not, are referred to as secondary emissions.

Hydrocarbons

Hydrocarbon emissions are generated both primarily and secondarily. In the pot itself, a certain amount of organic material is present in the anode which is liberated as the anode is consumed. Special burners on the pot serve as after-burners for the pot gases to combust most organic to CO_2, CO and H_2O prior to introduction to the primary treatment system. Similar hydrocarbons are driven off the anode top as previously described. This results in the blue haze seen near aluminum plants. Because the questions here relate to Anaconda Aluminum's plant at Columbia Falls, no discussion is presented here regarding emission variations from different aluminum manufacturing processes.

Particulate

In addition to the hydrocarbon particulates described above, large quantities of other particulate matter are emitted from the cells including some particulate fluoride. Dusting of the raw material during pot working is one major source. Other are solids from volatilized bath and entrainment of crust material in air. According to AAC, about

10% of total fluoride emissions are in particulate form and the particulate contains about 15-20% fluorine. Mechanical and electrochemical dusting of the anodes also contribute to particulate emission.

C. History of Plant and Existing Controls

The Anaconda Aluminum Plant at Columbia Falls was built in 1955. At this time the plant consisted of two pot lines with a total of 240 pots. The pollution control devices for air emissions were multiclones and low efficiency wet scrubbing systems. The original system made use of the multiclones as particulate collection devices, and the scrubbers were used almost exclusively as gas scrubbing devices. In 1965, one additional pot line was added to the plant bringing the total number of cells to 340 and this line was equipped with the same pollution control system as on the existing lines. In May of 1967 the State Board of Health adopted, after lengthy hearings, ambient air quality standards which included fluoride standards. In 1968, two more lines (240 pots) were added. It was estimated that emissions from the total plant were approximately 7500 lbs/day (15 lbs per ton of aluminum) of gaseous and particulate fluorides. The company made no estimates of 1968 emissions of particulate. By the summer of 1970 the Company reported fluoride emissions reductions from 7500 to 5000 lbs/day (15 to 10 lbs/ton) and obtained some reduction in the amount of particulate matter through the changes in the system operating parameters. In May 1970, the State Board of Health and Environmental Sciences promulgated a regulation restricting emissions of fluorides from aluminum plants, with an effective date of June 30, 1973, for existing plants.

Anaconda Aluminum had been studying various control systems and a program was instituted to replace the existing scrubbers with scrubbers of the venturi type. It was early 1972 before the full effect of the improvements and modifications to the control system were obtained and the Company reported total fluoride emissions from the plant of 2500 lbs/day (5 lbs/ton) and particulate emissions of 6500 - 8500 lbs/day. These levels have continued to the present. The regulation allows a fluoride emission of 864 lbs/day or 173 lbs/ton at full production. Testing of the scrubbers indicates that fluoride emissions from them approximate 500 lbs/day (1 lb/ton) which indicates that about 2000 lbs/day (4 lbs/ton) of fluoride are emitted into and then out of potrooms. To date, the extent of the particulate emissions are somewhat in doubt. The figures mentioned previously are based on operating experience and testing from several other plants, which indicates that particulate emissions generally run from 3-5 pounds of particulate matter for every pound of fluoride. The present system of control at Anaconda Aluminum is that of a primary collection only. There is no air pollution control equipment for emissions not collected in the primary system.

D. Company's Proposal Per Variance

AAC's petition perceives that compliance with Montana's regulations would necessitate the installation of collection devices for the emissions from the potroom roofs. Regulation S14080 allows fluoride emissions of 0.060 lbs/hr/pot. For AAC at full production this 36 lbs/hr or 864 lbs/day corresponding to about 1.73 pounds of fluoride per ton of aluminum. Best available data on particulate emissions from the plant, based on both AAC and state testing, indicate primary system emissions of 1,000 lbs/day (2.0 lbs/ton) and secondary emissions of from 6,000 to 8,000 lbs/day (12-16 lbs/ton). Montana's existing particulate regulation as of the date of AAC's variance petition was subject to interpretation, the most reasonable form of which would have allowed AAC to emit 9.4 lbs of particulate/ton of aluminum or 4700 lbs/day. The Department has proposed a modification of the particulate standard to be consistent with the fluoride standard in terms of technical feasibility, level of control and cost. Further discussion may be found in Section IIIC. The Department's proposed standard would permit particulate emission at a level 5 times that of fluoride emission or 0.30 lbs/hr/pot or approximately 8.65 lbs/ton of aluminum.

AAC's primary system is relatively efficient, although some other plants have better systems. Some improvements might be made to this system but even zero emissions from the primary system would not bring the plant into compliance.

The Anaconda Aluminum Company has proposed to study the use of foam scrubbers on the roof emissions. AAC recently has purchased and is experimenting with one very small pilot plant scrubber to give the company some operating data regarding the performance and the cost of such a device. The device being researched is not one familiar to the industry or the state. It is called the "Foamator" and was developed by Temperator A.B. of the Alfa-Laval group, Stockholm, Sweden. Presently, "Foamators" are available to handle gas flows up to 150,000 CFM but have never been used on aluminum plant effluents. A schematic of the scrubber was featured in Chemical Engineering magazine, November 26, 1973, page 28.

Conventional roof emission treatment requires large volumes of water in the system. Present practice elsewhere is once through use and discharge to a river. At Columbia Falls such a discharge would not be permissible so treatment would be required. The most important advantages of the foam scrubber would be its low volume of discharge and resultant volume requiring treatment. Preliminary estimates are the conventional system would require treatment of 25,000 GPM of water compared to 600 GPM for the "Foamator."

As the foam scrubber has not been used for aluminum plants, AAC is engaged in research and development (R & D) on its applicability. THe proposal for this work is contained in the variance petition. AAC presently has a 5' x 5' unit installed on one roof and a 10' x 10' unit is scheduled for lab testing in Sweden starting January 1, 1974. AAC proposes to test these units until June 1, 1974. Present testing has been to establish the best foaming agent, system efficiency, and certain other operating variables. As yet no results have been supplied to the state. Further testing is scheduled to determine scale up factors, cost data, optimum module size, auxiliary equipment requirements and long-term performance. Upon completion of testing on the 10' x 10' module AAC proposes to install sufficent units to treat emissions from 60 feet of roof-line for one year of testing. AAC proposes that, thereafter, if testing indicates economic and performance feasibility, additional units may be installed on one roofline for 10% of the total roof emissions. One additional year of testing is proposed for this installation.

AAC gives no assurance that the entire plant will be controlled, even if the "Foamator" scrubber proves out nor is any time schedule proposed for additional installations.

Moreover, no provisions have been made for alternate strategies.

AAC reports that it entered into an agreement with Alcoa and Alfa-Laval for this "Foamator" development. AAC will not divulge all relevant information. Such relevant information includes what the foaming agent is, how the foam bed is generated or controlled and what effluent treatment is under consideration. At this time the results of the testing have not been provided nor has any other information necessary to evaluate the device.

III. CONTROL METHODS AND COMPLIANCE

A. Technical Feasibility of Controls

There are a number of different methods both primary and secondary, for controlling the emissions from primary aluminum smelters. Conventionally, gaseous and particulate controls have employed two separate techniques or devices, although some methods achieve both. For the following discussion, control methods for primary and secondary emissions will be discussed separately as, in spite of some overlap, AAC's variance petition is couched in such separate primary and secondary treatment facilities.

Primary Control

Primary control at Columbia Falls is achieved with multiclones, venturi scrubbers, and packed towers. The multiclone is an inertial separation device used for preliminary particulate removal prior to the wet collectors. Contaminated air is introduced tangentially to several banks of cylindrical tubes with conical bottoms. Larger particles are forced to the outside of the cyclonic gas flow and removed from hoppers in the bottom. Partially cleaned air then passes up through the tubes into a duct to the venturi scrubber. Venturi scrubbers are high-energy, high pressure drop collectors. Gases are forced through a rectangular venturi tube in the throat, a rectangular constriction in the tube. Water is sprayed into the throat where it is atomized by the rapidly moving gas stream. Residence times are short, but the extreme turbulence promotes good solid-liquid contact. Particulates contact water droplets, thus increasing their size and therefore ease of removal. The packed tower is large diameter cylinder filled with material designed to provide large surface area in minimum volume. Gas velocities through the tower are low to provide time for gaseous components of the air stream to react with the liquid in the tower.

There are several types of efficiency figures used in discussion of air pollution control of aluminum plant effluent. The pot gas collection system attempts to convey pot gases to a primary control system in a relatively concentrated form. Some gases and pollutants are not collected by this system. Skirt efficiency, pot gas collection efficiency, and hooding efficiency are terms used to describe how much of the pot emissions are conveyed to the primary system for treatment, expressed as percentages of total pot gas. Treatment, collection, removal or system efficiency is percentage measure of how much of the pollutant entering a device is removed by the device.

Multiclones (MC) can achieve removal efficiencies of at least 90% for particles in the 5-10 micron (u)* range and higher for larger particles, lower for smaller ones. Expected efficiencies on pot gas fumes with an installation like that at AAC is about 45%. Venturi scrubbers (VS) are primarily particulate collection devices but some gaseous pollutant removal is obtained. In combination with the packed tower, the venturi should achieve almost 90% efficiency on particulates and 99% on gaseous fluorides. Testing of AAC's combined multiclones, venturi scrubbers and packed towers indicates that overall efficiencies for the system are 98.3% on total fluorides and 93.7% on particulate matter. This sytem as is being operated now, has emissions of total fluorides of 0.9 lbs F/ton Al or 450 lbs/day and of particulate of about 2.0 lbs/ton Al or 1000 lbs/day.

There are a variety of different systems in use at other plants around the world, and they are used with varying degrees of success. Some systems have not been applied to VSS pots like those at AAC. Those mentioned here are ones that are in use or could be used on such vertical stud pots. It should also be mentioned that efficiency figures and lbs/ton emission figures are not necessarily applicable to AAC's plant because of differences in pollutant concentration and nature of emissions, but do provide indication of what can and is being done. Pot design and layout, raw material variations, water supplies and treatment, and plant operation affect the emission data.

Martin-Marietta (formerly Harvey Aluminum) of the Dalles, Oregon, was built with practically a replica of AAC's pollution control system. It has been substantially improved three times in the last 10 years. It now employs a primary system of bubbler chambers followed by wet electrostatic precipitators (WESP). The bubbler chambers or bubbler scrubber (BS) are simply large concrete chambers with drains into which water is sprayed for HF removal. THe wet gases are then conducted to an electrostatic precipitator (ESP). Particles are given an electric charge and passed by oppositely charged conductors. The particles are attracted to and collected on these conductors. Periodically, the conductors are rapped mechanically to dislodge the collected material, which then falls into hoppers for removal from the device. A wet ESP collects wet particles and requires different design than a dry ESP (DESP). Usually no product recovery is obtained from wet ESP's. Martin-Marietta's system achieves "efficiencies of up to 99.66% on total fluorides and 99% on particulate" (9). However, wide variations in system efficiencies have been reported. Assuming similar efficiences, this would result in emissions at Columbia Falls of 0.13 lbs F/ton Al or 65 lbs/day of total fluoride (a reduction of 86%) and 0.78 lbs/ton Al or 390 lbs/day of particulate (a reduction of 60%).

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*1 micron = .000001 meter = 1/25,400 in.

A relatively recent innovation in the treatment of aluminum plant effluents is the "dry scrubber." THere are three varieties of this system--the fluidized bed (FBDS), coated filter (CFDS), and injected alumina (IADS). All three systems take advantage of the property of alumina to adsorb HF. Baghouses are employed to separate particulate matter from the contaminated stream.

The Alcoa 398 process, the fluid bed system, passes the pot gases through a reactor containing a fluidized bed of alumina. The alumina adsorbs gaseous HF. A baghouse is employed downstream to filter any entrained particulate matter. In the coated filter systems, either Alcoa 173 or Wheelabrator, the bag filters are coated with a layer of alumina from a source extraneous to the gas streams. Pot gases are passed through the filters with gaseous HF being adsorbed by the alumina and particles filtered by the alumina layer and fabric filter. THis sytem is being replaced by other dry scrubbing systems in several installations (10). These systems have one very beneficial consequence. As HF is adsorbed, it reacts with the alumina. The overall reaction is: $Al_2O_3 + 6HF \longrightarrow 2AlF_3 + 3H_2O$. The final result is AlF_3, one of the process raw materials. The collected material from these systems may be reintroduced to the pots without further treatment. As an aside, product recovery often is more valuable than the operating cost of the system, and actually becomes profitable.

The Alcoa 398 process is at least 99% efficient on gaseous fluorides and frequently above 99.9%. The associated baghouses usually trap 98% of the particulate (11). Overall fluoride efficiencies are 98.6% on prebake potline (U.S. installation) and 98.9% on VS lines (foreign)(10). Design on the coated filter system is 99% on particulate (and particulate fluoride) and 98% on gaseous fluorides. Actual operation of 98.2% on gaseous F and 99.3% on particulate have been achieved (12). The injected alumina system has been given a 98% efficiency on all pollutants, applied to U.S. prebake lines and foreign vertical stud lines (10).

A variation of the Martin-Marietta (MM) system is to put the precipitator ahead of the scrubber or gas removal device. Such a system is employed by Montecatini Edison at several of their plants in Italy. The dry ESP is placed first in the system for particulate removal. THis had advantages over the MM system because of the recovery of dry products which can be reused, and because of elimination of the solids buildup in the scrubber waters. Also, materials handling is simpler than with a wet ESP. Two consecutive scrubbers use a 2.5% NaOH caustic solution. The scrubbers are merely spray towers (ST) in which the gas stream passes upward and water is sprayed down. Scrubbing water is treated for fluoride recovery. Precipitator efficiencies of 96-97% and overall system efficiencies of 99% on solids and 99.6% on fluorine are claimed (13).

Another system in use is very similar to Martin Marietta's, except that the bubblers are replaced with packaged wet scrubbers. The wet scrubbers can be one of several designs and their primary purpose is control of gaseous fluoride emissions. Types used are spray towers, venturis, and packed scrubbers. Gaseous removal efficiencies of 98-99% are not uncommon (14). The wet precipitators are similar to those previously described.

SAKO's Sundsvall aluminum works in Sweden uses a floating bed of plastic balls in the primary system scrubber. The packed bed (PB) scrubber is a cylindrical tower containing about 15,000 1½" plastic balls. The balls are retained by plastic nets and water is sprayed upwards from below concurrent with the gas stream. The plastic balls serve a purpose very similar to the packing in a packed tower, except the balls are fluidized and internal action is much more violent. 78% removal of solids and 97.5% of fluorides are the operating efficiencies of this system (15). Refer to Table 6a for a comparison with Anaconda Aluminum.

A venturi scrubber used by itself for both fluoride and particulate control is another system available. Removal of 96% and 99% on solids and HF respectively have been designed (14). However, such efficiencies require very high energy inputs and results can frequently be achieved with other systems at lesser costs.

Secondary Control

Aluminum reduction cells generate and lose tremendous quantities of heat. To maintain a suitable working environment for plant personnel, both fluoride and hydrocarbon concentrations and temperatures must be reduced. Large volumes of outside air are admitted to the building for dilution, thereby lowering the potroom temperature and pollutant concentrations.

Both ground and roof supported units are used and all employ a water, treated or untreated, scrubbing medium.

The spray chamber (SC) system used by Martin-Marietta, is a combination of roof units and tunnels utilizing a number of roof-mounted fans to draw the potroom air through a series of water sprays. Fresh water is used in the sprsys, and the water collected in troughs below the sprays is discharged to the river. Efficiencies are 88% on gaseous F, 42% on particulate F and 77% on total particulate (9). Table 6b presents comparisons of possible treatment methods with existing emissions levels at Columbia Falls.

A VSS plant in Nogueres, France, owned by Pechiney, is equipped with tubular atomizers. These are horizontal tubular scrubbers mounted in the roof ventilators. Potroom gases are drawn into one end of the scrubber and sprayed with a caustic solution. The effluent is treated for fluorine recovery and recycled. A similar device is used at Intalco Co. in Ferndale, Washington. Fluoride removal of 80 to 85% in the roof scrubbers is achieved (16). Refer to Table 6b for emissions comparison. These emissions comparisons become more informative when one is aware that both AAC's Columbia Falls plant and MM's The Dalles plant were built from the same Pechiney plans. Even at that time (1955), Pechiney was employing better pollution control systems that were installed in the U.S. plants. Pechiney also is part owner of the Intalco plant. Table 6c compares the total lbs/ton emissions from the Intalco plant to AAC's lbs/ton emission. Total emissions are not presented because of the difference in plant size.

The spray tower (ST) is very similar to the spray screen except it is set up on the ground, at least as SAKO's Sundsvall, Sweden plant. Potroom gases are drawn from the roofs and forced down through a tower, then up where they contact downflow water on a grid packing. SAKO has installed a different device on the same plant but the principle is essentially the same. SAKO claims 70% removal of solids and 87% of fluorides and 67% SO_2 reduction (15).

Montecatini Edison's Italian plants control secondary emissions with roof-supported units mounted at one edge of the building. Gases are passed through two screens with water sprayed counter currently onto the screens. Fluorine removal of 70% and solid removal of 50% are attained (13).

The Mosjoen Aluminiumverk, Norway, has had a secondary system in use since 1958, but in 1970 replaced it with a new system. This ground supported unit is much like others in several respects. Potroom gases are taken from the roof monitors and ducted into the bottom of the towers. Fresh sea water is sprayed down onto wooden grids, countercurrent to the gas flow. Treatement efficiencies in the secondary system are 90% on total fluorides and 50% on particulates. The plant has four potrooms each equipped with 5 towers. Total plant capacity is 90,000 metric tons (99,000 short tons) per year (17).

One other system deserves mention. Pechiney at one of their most recently constructed lines took a slightly different route. Instead of installing both primary and secondary control on the 139 KA prebaked anode pots, only one system was installed. The pot gases are vented to a roof scrubbing system along with ventilation air. Potline layout and ducting is different than similar pot types. Pechiney claims over 90% removal of HF (18).

TABLE 6a
Emission Comparisons - Primary System

			Emissions Adapted to AAC			
	Efficiencies		Particulates		Fluorides	
System	Part	Fluorides	#/ton	#/day	#/ton	#/day
AAC uncontrolled	0	0	31.8	15,900	47.7	23,850
AAC existing MC & VS	93.7	98.3	2.0	1,000	0.9	450
Martin-Marietta BS & WESP	99	99.66	0.32	160	0.16	80
Alcoa 398	98	99	0.64	320	0.48	239
CFDS	99.3	98.2	0.22	110	0.85	425
Montecatini-Edison DESP & ST	99	99.6	0.32	160	0.19	95
SAKO-Sundsvall PB	78	97.5	6.99	3,495	1.19	595

TABLE 6b
Emission Comparison - Sec. System

			Emissions Adapted to AAC			
	Efficiencies		Particulates		Fluorides	
System	Partic.	Fluorides	#/ton	#/day	T/ton	#/day
AAC uncontrolled (existing)	0	0	12- 16	6000 8000	4.5	2250
Martin-Marietta SC	77%	88%	2.8 3.7	1440 1850	0.54	270
SAKO-Sundsvall ST	70%	87%	3.6 4.8	1800 2400	0.58	290
Montecatini-Edison ST	50%	70%	6 8	3000 4000	1.35	675
Mosjoen Aluminumwerk ST	50%	90%	6 8	3000 4000	0.45	225

TABLE 6c
Overall Emissions Comparison
AAC - Intalco

	Total Fluoride	Total Particulate
Anaconda Aluminum	5.4 #/ton	14-18 #/ton
Intalco (1973)	1.03 #/ton	4.33 #/ton

B. Cost of Control

The preceding narrative has established that the technology exists to control secondary emissions from aluminum smelters. Various methods are available.

Cost data for secondary systems are sparse and not particularly detailed. Most of the data, especially capital costs, is 1970 or earlier. Chemical Engineering publishes economic indicators or factors for a variety of industrial costs and prices. The following table has been prepared from the December 10, 1973, issue of Chemical Engineering(e).

Year Index Type	1957-59	1968	1970	1972	1973*
CE Plant Cost	100	113.7	125.7	137.2	145.0
Equipment & Machinery					142.0
Construction Labor					156.3
Engineering & Supervision					130.1

*As of August, 1973

Of the systems mentioned, the one installed by Martin Marietta is probably the most analagous to Anaconda Aluminum. Both are vertical stud plants, located in the same general geographic area of the U. S., served by the Bonneville Power Administration and close to the generating stations, and both are similarly designed. The available data is from The Dalles plant which has 5 potrooms of about 1000 feet in length each containing 60 pots, with a total plant annual capacity of 91,000 tons of aluminum. Anaconda Aluminum's plant is approximately twice the size of Martin Marietta.

After completion of modification of the MM system in late 1970, MM applied for tax relief to the State of Oregon. The total cost in the application was $4,155,077.94. However, the Martin Marietta system has no scrubber water treatment facilities. THere are estimates of water treatment facilities capital costs as $130 per gallon per minute to be treated (10). Assuming 25,000 GPM of scrubber water, this would cost about $2.3 million 1970 dollars. Total for such a system at Anaconda Aluminum would cost approximately $10.6 million or 58.80/ton of annual capacity.

The Pechiney plant at Nogueres, France, uses 100,000 amp VSS pots with a total annual capacity of 110,000 metric tons (121,000 short tons). Air volumes are somewhat lower than encountered at Anaconda Aluminum. Total cost of the primary, secondary, and fluoride recovery systems was $5 million for 3 lines of cells, equivalent to about $41 per capacity ton produced to achieve approximately a 93% overall collection efficiency on fluorides (16). SAKO's Sundsvall plant has invested during 1962-1970 $4.25 million ". . . as investments made for controlling and minimizing the influence from the plant on the environment." This plant has a present output of approximately 66,000 metric tons per year (78,600 short tons per year) or a cost of $54 per ton of capacity. This includes cost for both primary and secondary systems. Overall efficiency for the whole system is 72% on particulate matter, 95% on fluorides and 79% on sulfur dioxide (15). The Montecatini Edison plant reports that for its air pollution systems installation costs were 2 lire per kilogram of aluminum, operating costs were 5 lire per kilogram of aluminum and total expenditure was 7 lire per kilogram of aluminum based on capital and interest amortization of 15 years at 8½%. System efficiencies in the primary system are 99% on solids, 99.6% on total fluoride and in the secondary system 50% on solids, and 70% on total fluoride (13).

AAC has provided very limited cost projections for the foam system Some suggested estimate is that control of one potroom will cost $1.45 million. If costs were similar for the rest of the plant, total capital costs would be about $14.5 million, apparently without costs for water treatment, which would be small because of the small volume to be treated. It is assumed that capital costs per unit capacity would be less on plant-wide installation than on the experimental prototype.

In 1970 the Mosjoen Aluminumverk in Norway replaced their old system with a new one. They reported capital costs of $4.5 million and operating costs of $350,000 per year for this system. Total plant capacity is 90,000 metric tons (99,000 short tons) per year, resulting in an installed capital cost of about $45.50 per capacity ton (17).

C. Compliance

The Department presently has in existence three regulations which are wholly or partly applicable to aluminum reduction plants. One regulation which has not been mentioned previously is the visible emission regulation. Compliance with fluoride and particulate regulations, however, should achieve compliance with visible emission regulations.

The state has a regulation restricting the emission of particulate matter from industrial processes. This is known as the "process weight law" and is applicable to all industrial processes not specifically exempted. Allowable particulate emissions are based on the amount of raw materials processed in the operation. The third regulation applicable to the aluminum smelter is S14080 which was created specifically for aluminum plants to restrict the fluoride emissions The proposed amended regulation, S14080, restricts particulate emissions specifically for aluminum plants.

The fluoride restrictions as stated in the regulation are 0.06 pounds of fluoride per hour per pot. THis is approximately 1.73 pounds of fluoride ton of aluminum produced, at full production If AAC were operating at full production, total fluoride emission would be limited to 36 lbs/hr or 864 pounds per day. There are several secondary emission control systems, which when added to Anaconda's existing primary control system will achieve compliance with the fluoride regulation.

Compliance with the general particulate regulation was difficult to interpret for aluminum companies. The proposed changes would restrict total particulate emissions to approximately the same range which would have been the best interpretation of the existing "process weight" regulation. The proposed amended regulation is consistent with the policy of the Department to achieve a level of particulate matter emission control similar to that for fluorides. The new regulation would restrict emissions to approximately 8.65 lbs of particulate per ton of aluminum. This is based upon the estimate of the particulate emissions from the roofs of the Columbia Falls plant at its full aluminum production. Like the fluoride regulation, the particulate regulation is phrased in terms of pounds per hour per reduction cell and limited to 0.3 such pounds. A rule of thumb has estimated that particulate emissions can be controlled to a ratio of 5:1 as compared to fluoride emission; the proposed particulate regulation continues to be consistent with that ratio.

IV. EXISTING ENVIRONMENT AND POLLUTANT EFFECTS

A. Topography

Anaconda Aluminum Company's Columbia Falls' plant is located in Northwestern Montana, about 2 miles ENE of Columbia Falls, in Flathead County. The plant sits at the base of Teakettle Mountain, a rather barren mountain in the Whitefish Range of the Rocky Mountains. To the South the Flathead River flows westerly from Hungry Horse Reservoir towards Kalispell and Flathead Lake. To the North the Whitefish Range bends toward the West forming the northern boundary of the Flathead Valley. The western boundary of the Flathead Valley is the Salish Mountains.

Elevation at Columbia Falls is 3037 feet (MSL) and Kalispell 2936 feet (MSL). Elevations in the vicinity are quire varied given the proximity of Glacier National Park with Mt. Cleveland at 10,440 feet. Glacier National Park lies north and east of the plant with the nearest point less than 6 miles northeast. The mountains bounding the valley generally range from 5000 to 7000 feet.

There are numerous mountain streams and lakes in the area, in addition to major bodies of the Flathead River and Flathead and Whitefish Lakes. The Hungry Horse Reservoir created for generating hydroelectric power, lies a few miles SE of the plant and provides 148,000 KW or 40% to AAC for operation of the plant. The valley lies at the upper end of the Columbia River drainage basin.

B. Population

The largest town in the area is Kalispell with a population of 10,526. Columbia Falls has a population of 2652. Other towns in the area have populations as follows:

Whitefish	3349	Hungry Horse	700
Olney	250	Martin City	500
Somers	889	Coram	500
Lakeside	600	Kila	48
Bigfork	500	Rollins	100
Creston	25	Apgar	20
Marion	150		

The aggregate total of this urban population is 20,809. The total rural and suburban population of Flathead County is 18,650. The total county population is 39,460.

C. Land Use - Social Setting

A large portion of the total area of Flathead County is taken up by Flathead Lake and some rather rugged mountains. Conventional agricultural pursuits such as cattle raising and crop farming are pursued, particularly in the "lowlands." Much of the mountainous country is forested and contained within National Forest boundaries and some additional forest is controlled by the state and by private interests. Use of the forest constitutes one, if not the, major land use in the area. The wood products industry, primarily sawmilling, is a large user of the forests and a large employer in the valley.

Agriculture found in the valley is quite varied. The Flathead Valley, especially the East Shore of the lake, is well known for its cherry crops. The north end of the lake has a considerable amount of Christmas tree farming, corn raising, and wheat ranching. There are some 1200 farms and ranches in Flathead County.

In the valley Anaconda Aluminum is the major heavy industry. There are a few secondary manufacturing and fabricating industries found, deriving their input materials from locally available sources, primarily sawmills.

In general, western Montana is oriented toward the wood products industry as opposed to the agricultural leanings east of the Continental Divide. Consistently the social settings of the two areas differ, though not greatly. Low population densities, moderate incomes, a certain remoteness all lend themselves to a life style considerably different from larger metropolitan areas. A greater association with outdoor activities and generally low-keyed relationships characterize the day to day living of area residents.

Another prime use of land in the Flathead Valley as in much of Montana is recreational. Many of the recreational pursuits provide a dual use of the forests. The usual range of recreational activities such as hunting, fishing, camping, boating, hiking, snowmobiling, skiing, are practical to varying extents throughout the area.

In light of the recreational activities found, it is not surprising to find that tourism is a major item of commerce for the area. Both summer and winter offer opportunities to visitors of the area. Glacier Park is a large drawing card for the Flathead Valley and the area provides a close and reasonably complete source of goods and services for those visiting the park. The prime attraction of Glacier is its scenic beauty; rugged mountains, diverse and plentiful vegetation and clear skies. Healthy trees, not only for their aesthetic values, but as food for animals and proper operation of the ecosystem are a necessity. This situation is becoming increasingly important as other areas of the country, even in Montana, feel the effects of population and pollution. Damages occurring in the Park and the forests are discussed later.

D. Meteorology and Climatology

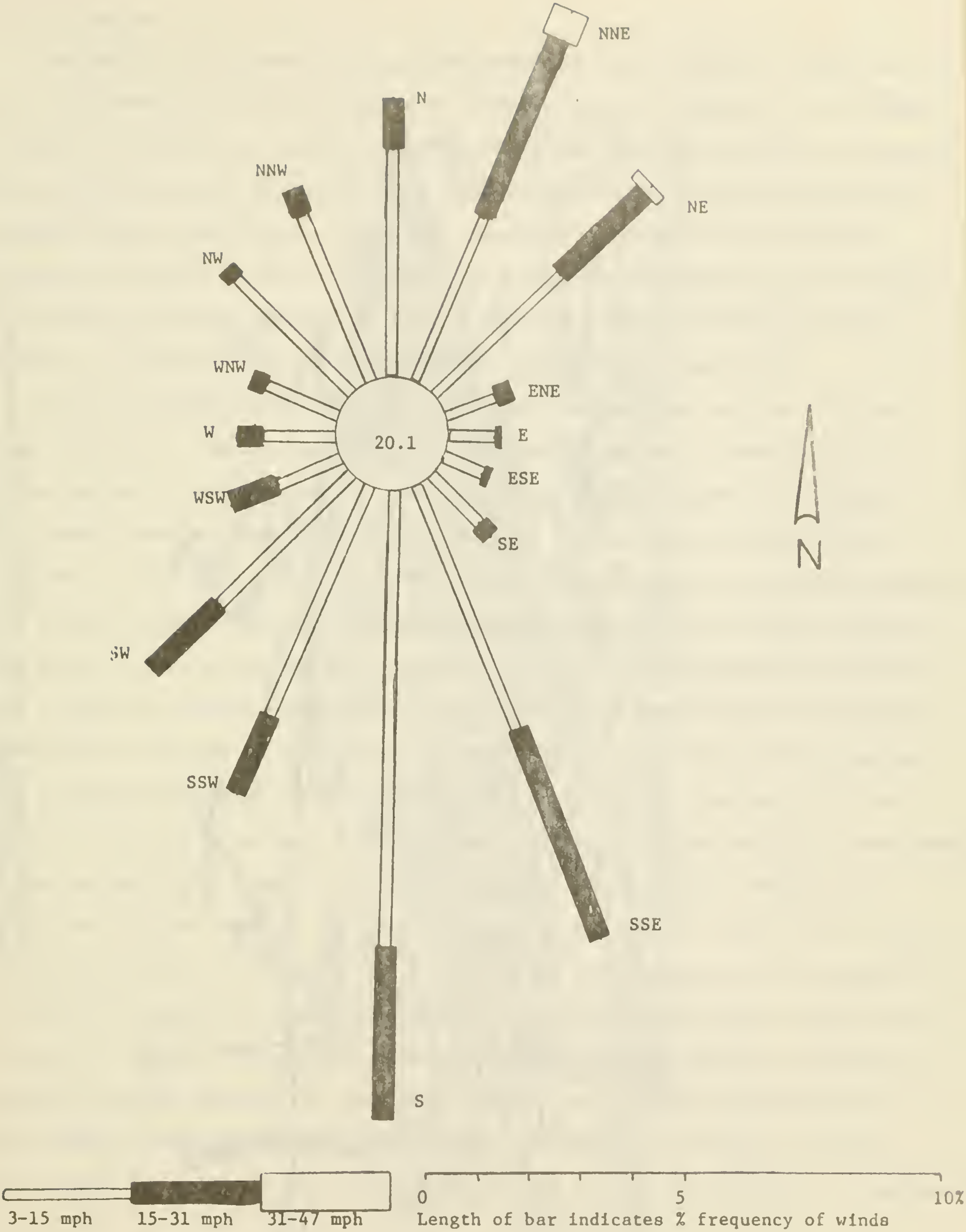
The following, courtesy of the U. S. Department of Commerce, National Oceanic & Atmospheric Administration, Environmental Data Service, is a narrative climatological summary of the Flathead Valley. The weather service station is located at Glacier Park International Airport between Kalispell and Columbia Falls.

> "Since the climate of the Flathead Valley differs materially from that just east of the Continental Divide (The Divide is approximately 40 miles to the east of the station), it can principally be attributed to the influence of the topographical features. The high mountains to the east form an effective barrier to many severe winter cold waves that move down over sections east of the Rockies from Alberta. The mountains to the east rise abruptly 4,500 feet above the valley floor. Their elevation and snow remaining on the crests until late spring assure frequent and beneficial rains by cooling of moist air moving from the west.
>
> "In addition to Flathead Lake, the valley contains four smaller lakes, three rivers, and numerous streams and sloughs. Until late in the winter when a large portion of the lakes and sloughs become frozen over, this water surface tends to limit temperature extremes. This effect is most noticeable in the southern end of the valley, because of more influence of Flathead Lake. Due to its size, Flathead Lake seldom freezes over.
>
> "The weather at the airport is considerably different in some respects from the weather in Kalispell. Generally there is more cloudiness at the airport since it is closer to the mountains to the east and north. Moist air moving in from the west and southwest, lifting and cooling as it moves over the mountains, is the major cause. In connection with this, there is averagely more precipitation on the east side of the valley than on the west side. Average snowfall during the winter at the airport is 67 inches and in Kalispell it is 49.4 inches.
>
> "Starting in March and lasting through September the prevailing wind from 11:00 a.m. until 7:00 p.m. is from the woutheast. This wind blows off Flathead Lake and is caused by the land surfaces heating more in the daytime than the water surface of the lake. This wind is very noticeable both at Kalispell and

> and the airport, often reaching 20 m.p.h. and occasionally quite gusty. There are, of course, times when the wind during this period is not from the southeast. Other effects such as cloudiness, frontal passages, etc., may cause the wind to be from another direction. The year around prevailing wind direction at Kalispell is from the west, at the airport it is from the south. Wind speeds average considerably stronger at the airport than in Kalispell.
>
> "In the winter, when a cold wave moving down the east side of the Continental Divide does come through the mountains, the airport is in direct line of the pass the cold air comes through. During these cold waves the wind is from the northeast and will usually have speeds reaching 50 to 60 m.p.h. The strongest gust reported during one of these storms was 84 m.p.h. As the cold air moves down the valley it spreads out, decreasing the wind velocity, and mixes with the warmer air of the valley. Unless these cold strong winds persist for 3 or 4 days, the wind in the lower part of the valley will be from the northwest, because of the influence of Flathead Lake and the mountains to the west. This wind is always much stronger in the northeast end of the valley where the airport is located than any other place in the valley. In the northwest corner where Whitefish is located, and in the southeast part of the valley, there is rarely much wind from this storm."

Annual precipitation averages 15.42 inches compared with a total of 14.63 in 1972. Snowfall at the airport averages 67" per year with a 1972 total of 76.1". The following wind rose, Figure 2, has been prepared from the most current wind rose in use by the Weather Service.

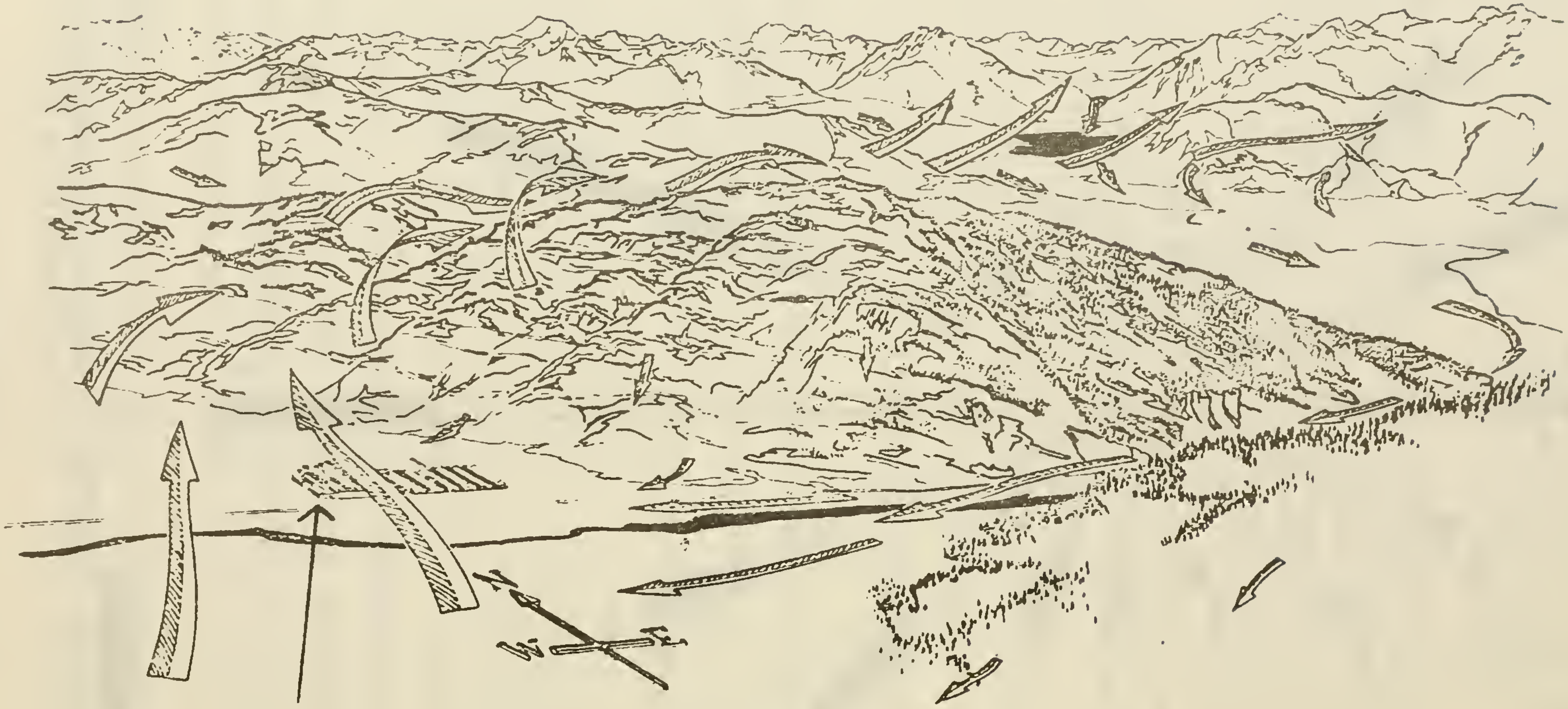
The Environmental Protection Agency (EPA), formerly NAPCA, recently released a report on fluoride studies conducted in and around Glacier Park. They postulated that diurnal variations in wind have a significant effect on fluorides reaching the Park. Nighttime winds flow from the east to west out of Badrock Canyon but currents are not strong. The patterns are depicted in Figure 3. Plant effluent is not diluted as much as during the day and accumulates above the plant. The effluents rise but have insufficient buoyancy to reach the crest of the mountains. Daytime flows are generally in a northeasterly direction. Current and accumulated emissions are carried over the saddle in Teakettle toward the Park, as they rise into the prevailing southwest upper winds. This effect is most pronounced around mid-morning; later in the day the previous accumulation of pollutants has been removed and only that day's current emissions are involved.



Length of bar indicates % frequency of winds from direction of bar.

FIGURE 2

FIGURE 3



Simplified drawing of typical midmorning wind-flow patterns in Upper Flathead Valley.

E. Air Quality

The quality of the ambient air in the Columbia Falls area continues to exceed various state and federal air quality standards on numberous occasions, although it has improved somewhat in recent years. Table 7 summarizes state and federal standards for particulate matter and fluorides in the ambient air. Comparing them with 1973 sampling results, it becomes obvious, looking at the table, that there must be further reductions in the levels of pollutants in the air to achieve the standards. Such reductions will probably be necessary in varying degrees from all the emissions sources, including Anaconda Aluminum, the wood products industry and urban sources such as dusty roads.

Sampling for particulate matter at two stations is summarized in Table 8 for the years 1971-1973. A description of sampling stations is included in Appendix B. The table includes the annual geometric means and high and second highest values during the periods reported. Table 9 presents the state's data on ambient fluoride levels obtained from calcium formate papers. The formate paper technique is a relatively simple but effective means of determining average concentrations of fluoride in the ambient air. The technique however does not allow recording of peak short-term values for fluorides but it has been shown to provide some indication of the exposure of plants to fluorides. Table format indicates the average for the period, the maximum reading obtained during the period and the number of violations and the number of months data included in the period. The stations included in the table are generally those stations which experienced higher readings but a Columbia Falls station has also been included. Perhaps most useful are the three stations for which the state has accumulated 5 years of data. It is significant that at 2 of the 3 stations values are still exceeding state standards by substantial margins although it is apparent that some reductions have occurred over the past few years. Further, some of the Teakettle Mountain stations are subjected to extreme levels of fluorides, at times exceeding the state standard by a factor of 30. The limited sampling from Glacier Park stations recently established have been below the standard for gaseous fluoride, but the vegetation in the park continues to accumulate

TABLE 7

AMBIENT AIR QUALITY STANDARDS

Pollutant	Averaging Period	State of Montana Standard	U.S. EPA Standard	1973 Sampling
Total Suspended Particulate	Annual Geometric	75 ug/M^3	60 ug/M^3	73 ug/M^3 (0270002)
	24-hour	200 ug/M^3 (a)	150 ug/M^3 (b)	475 ug/M^3 (0270002)
Fluorides Total AS (HF)	24-hour	1 PPB (c)	-	
Gaseous	28 days	0.3 ug/CM^2 - 28 days		
	30 days (d)	0.321 ug/CM^2 - 30 days		10.850 ug/CM^3-30 days (0480015)

(a) Not to be exceeded over 1% of days in a year
(b) Not to be exceeded more than once a year
(c) PPB - volume, parts HF per billion parts air
(d) Standard is for 28 days
Computerized data reported for 30 day

(Site ID)

TABLE 3

TOTAL SUSPENDED PARTICULATE
ug/M^3

High School 1971			High School 1972			High School 1973			Dehlbom's 1973		
Month	Geom. Mean	hi/2nd hi	Month	Geom. Mean	hi/2nd hi	Month	Geom. Mean	hi/2nd hi	Month	Geom. Mean	hi/2nd hi
			Jan	N.D.		Jan	51	253/138			
			Feb	21	74/32	Feb	53	103/38			
			Mar	68	196/32	Mar	109	457/204			
April	101	191/176	April	40	196/108	April	94	281/167			
May	159	221/154	May	57	248/112	May	108	238/198	May	37	72/68
June	91	255/246	June	85	221/217	June	66	143/135	June	32	73/62
July	258	474/441	July	106	126/110	July	93	142/114	July	54	127/121
Aug	164	329/328	Aug	125	240/224	Aug	80	132/121	Aug	59	143/135
Sept	139	390/294	Sept	105	276/184	Sept	54	103/94	Sept	25	61/57
Oct	205	447/352	Oct	504	504	Oct	56	216/149	Oct	32	69/43
Nov	221	229/214	Nov	116	256/227	Nov	34	117/33			
Dec	N.D.		Dec	40	283/196						
1971 CUM	153	474/447	1972	69	504/283	1973	72	457/281	1973	40	143/135

minus Ap and May (162)

TABLE 9

Calcium Formate Papers
Selected Stations
F ug/CM^2 - 30 days

Average / Maximum   Number of Violations / Number of Months Data

Station	1973		1972		1971		1970		1969	
936 9th Avenue 0270 001	0.265 0.470	3 10	0.242 0.700	2 12	0.539 1.200	6 8				
Dehlboms 0480 002	0.471 0.870	6 9	0.881 1.640	12 12	1.097 2.100	10 11	1.048 1.500	9 9	4.335 9.080	8 8
Feirstein 0480 003	0.373 0.620	6 10	0.542 1.130	8 12	0.771 1.500	10 11	0.699 1.200	8 9	1.617 3.100	7 8
Badrock Substa. 0480 005	0.169 0.250	0 10	0.412 0.610	9 12	0.460 0.730	9 11	1.163 4.800	7 9	1.244 3.780	8 8
Dehlbom's Field 0480 013	0.489 0.980	6 9	1.064 2.700	8 8						
Anaconda So. 0480 013	3.081 5.560	9 9	8.570 10.070	7 7						
Teakettle Mtn. #2 0480 015	5.408 10.850	6 6	7.451 12.070	7 7						
Teakettle Mtn. #6 0480 019	2.861 3.880	10 10	5.357 15.730	4 4						
Teakettle Mtn. #8 0480 022	0.226 0.310	0 5								
Glacier Park #1 0570 003	0.073 0.080	0 3								
Glacier Park #2 0570 004	0.140 0.160	0 3								

significant quantities of fluoride and damage continues to occur. Further discussion on this can be found in the subsection on vegetation. The National Air Pollution Control Administration (NAPCA) now contained in EPA has sampled in the area for fluorides to obtain data for a report on fluoride pollution in Glacier National Park. The EPA report in general substantiates the state's data (19). A copy of EPA data and site identification is included in Appendix B.

From June 1963 to June 1964 the State Board of Health, Division of Disease Control conducted a study on suspended particulate and polynuclear aromatic hydrocarbons (PAH) at Creston, Kalispell, and Columbia Falls (20). Analysis was performed on suspended particulate for variety of PAH compounds such as benzo-a-pyrene, fluoranthene, coronene, etc., which have been implicated as cancer producing agents. Results indicated that the fraction of PAH relative to the amount of benzene soluble (organic) was considerably higher in Columbia Falls than in Kalispell, and Kalispell was higher than Creston. The ratio of total PAH to total particulate was considerably higher in Kalispell and Columbia Falls than in Creston, and Columbia Falls was slightly, but insignificantly, lower than Kalispell. Perhaps the most important factor is the total PAH in the ambient air expressed in micrograms per 1000 cubic meters. For example, Creston had 11.1 ug per 1000 cubic meters, Kalispell 25.6 and Columbia Falls experienced 40, a significant difference. Also total suspended particulate levels at this time were as much as 3 times as high in Columbia Falls as those in Kalispell or Creston.

F. Human Health

Fluoride

Much of the work done relating fluoride intake to effects on the body has dealt primarily with ingested fluoride, i.e., F content in water and food. Some work has been done in relation to establishing occupational exposure levels, but very little research has been done relating ambient air concentrations to effects on humans.

Hydrogen fluoride gas is a pulmonary irritant but more damage occurs in the calcified structures (bones and teeth). Other effects may include loss of body weight and altered

TABLE 10

Mean Concentration HF in air mg/m^3	Total F in Ration, Diet or Water ug/k	Mean Daily Intake Milligrams (MG/Day)	Duration	Effect
$\geq$ 0.1	-	-	Single Exposure	perceptible odor conc. for HF
2.5			Daily	TLV 8 hr. ACGIH
$\approx$ 25			Single Exposure	tolerable, with conjunctival and respiratory discomfort only for several minutes
$\approx$100			Single Exposure	highest tolerable conc for 1 min marked conjunctival and respiratory irritation
		0.2-1.2	Daily	avg. daily intake, USA Food and Water
	2-8 (water)		Years	mottled enamel (formative years)
	40		Several Years	loss of body weight
	$>$50		Months-Years	thyroid injury
	$>$100		Months	renal injury
		20-80	10-20 Years	crippling fluorosis
		2,500-5,000	Single Dose	death in 2-4 hours

structure and function of the thyroid gland and kidney where ingested fluoride is the source (21).

Table 10 (16) summarizes the effects of fluorides on humans. The data in that table are practically the only published data available but are subject to question.

The American Conference of Governmental Industrial Hygienists (ACGIH) publishes allowable limits for occupational exposures. If one notes from Table 10 an average daily intake of 0.2-1.2 milligrams (mg), an 8-hour HF concentration of 2.5 mg/M^3 permits an intake of 25 milligrams assuming 10 M^3 air inhalation in 8 hours. However, Montana's ambient air standard is one ppb (0.8 micrograms per cubic meter (ug/M^3)), which permits a daily intake of 16 ug or .016 mg, assuming 20 M^3 inhalation in 24 hours. A figure of 25% absorption has been used but not documented. From these data it appears that an ambient air standard such as one ppb allows a fluoride intake amounting to somewhere between 0.25 and 2% of the average daily intake.

It has been observed that fluorides, like mercury, are concentrated in the food chain; therefore, persons residing under the influence of fluoride emission may accumulate significant quantities in the body from water, locally raised fruits, vegetables, and livestock, occupational exposures, etc. (22).

Particulate

Particulate matter has been significantly linked to health effects on man. The effects are largely those relating to the respiratory system as opposed to the intake levels of fluorides. The observed high values (24-hr.) of suspended particulate may be exposing area residents to unnecessary risk, as will be seen later.

> HEW, PHS, EHS publication #AP-49 states: "Particulate matter may exert a toxic effect via one or more of three mechanisms:
>
> 1. The particle may be intrinsically toxic due to its inherent chemical and/or physical characteristics;
> 2. The particle may interfere with one or more of the clearance mechanisms in the respiratory tract.
> 3. The particle may act as a carrier of an adsorbed toxic substance."

The following tables were extracted from a report prepared by the health effects personnel in EPA National Environmental Research Center at Research Triangle Park, North Carolina. In light of the health effects observed in Tables 11 and 12, thresholds were estimated to prevent such effects from occurring or to minimize the effects on the total population according to EPA. The safety margin included in the standards is negligible for the 24-hour standards but about a 33% safety margin over the annual averages (Table 13). A sizeable portion of the population will be subjected to risk of symptomatic occurrence of various adverse effects (Table 14).

Possibly more significant is the presence of polynuclear aromatic hydrocarbons (PAH) of a carcinogenic nature (benzo-a-pyrene, benz-k-fluoranthene, etc.). The coal tar pitch used as anode paste at Anaconda Aluminum contains significant quantities of PAH. In fact, coal tar pitch ". . . is composed almost entirely of polynuclear aromatic compounds . . .Hazard: highly toxic by inhalation." (23)

An extensive literature review, Preliminary Air Pollution Survey of Organic Carcinogens, NAPCA publication APTD 69-43, states that "a correlation between the incidence of cancer and any single suspected environmental factor is extremely difficult to establish as well as quite limited in usefulness." (Emphasis supplied) (24). Nevertheless, there exists a well accepted correlation between increased lung cancer incidence and exposure to polluted air. Several researchers, in attempting to establish atmospheric carcinogen-lung cancer correlations, concluded that such correlations existed. Kotin and Flak, Ref. 121 in the above publication, reasoned as follows:

> "(1) Carcinogenic agents have been identified and quantified in the polluted air of essentially every city in which they have been sought;
>
> (2) Similarly, chemical compounds with known tumor-promoting properties have been identified and quantified in polluted urban air;
>
> (3) The stability and survival of carcinogenic hydrocarbons in the atmosphere are compatible with inhalation and a postulated biological effect in those exposed;
>
> (4) Carcinogenic agents, as well as noncarcinogenic respiratory epithelial irritants, occur in the atmosphere in a state compatible with host entry and tracheobronchial deposition;

TABLE 11

Adverse Health Effect	Concentration at which effect was observed	
	Concentration (ug/M^3)	Averaging Time
1. Increased mortality	750 or a rise of 200	24-48 hours
2. Increased infant mortality & cancer deaths	>200	3 days
3. Increased upper respiratory infection & cardiac morbidity	375*	24 hours
4. Excess bronchitis mortality	200	24 hours
5. Acute worsening of symptons in bronchitis patients	300	Daily
6. Increased mortality from chronic respiratory disease and all causes	100	2 years
7. Increased chronic respiratory disease prevalence in adults; increased upper & lower respiratory tract disease and diminished pulmonary function in children	100-200	Annual

*converted from 3 COH units (let 1 COH = 125 ug/M^3

TABLE 12

Adverse Health Effect	Concentration at which effect was observed	
	Concentration (ug/M^3)	Averaging Time
1. Increased cough, chest discomfort & restricted activity	100-269	24 hours
2. Aggravation of cardio-respiratory symptoms in healthy persons, and in elderly patients with heart and lung disease; increased asthma attacks in people with asthma	80-100	24 hours
3. Aggravation of cardio-respiratory disease symptons in elderly patients with heart or chronic lung disease	76-260	24 hours
4. Decreased pulmonary function in school children	110	Annual
5. Increased frequency and severity of acute lower respiratory disease in school children	100	Annual
5. Increased chronic respiratory disease symptom prevalence in adults	100	Annual

TABLE 13
SAFETY MARGIN INCLUDED IN TOTAL SUSPENDED PARTICULATE STANDARD

Adverse Effect	Concentration in ug/M^3 Threshold Estimate	Concentration in ug/M^3 Primary Standard	Safety* Margin (%)
1. Excess mortality	250-300 100-175	260 (24 hr) 75 (annual)+	None 33 to 133
2. Aggravation of symptons in elderly	80-100	260 (24 hr)	None
3. Aggravation of chronic lung dis.	>250	260 (24 hr)	None
4. Aggravation of astma	100	260 (24 h4)	None
5. Acute irritation symptoms	170	260 (24 hr)	None
6. Decreased lung function in children	100	75 (annual)	33
7. Increased prevalence of chronic bronchitis	100	75 (annual)	33
8. Increased acute upper & lower respiratory illness in families & in school children	100	75 (annual)	33

*Safety Margin $= \left(\frac{\text{Threshold-Standard}}{\text{Standard}}\right) \times 100$

+Geometric mean

TABLE 14
ESTIMATED POPULATION AT POTENTIAL RISK TO POLLUTANT-INDUCED EFFECT

Adverse Health Effect	Expected Proporation of the Population at Risk (Rate per 100)	Expected Size* of Population at Risk
1. Mortality	23+	32,220,000
2. Sympton aggravation in elderly	23+	32,220,000
3. Aggravation of chronic lung disease	20 to 40	28,000,000 to 56,000,000
4. Aggravation of asthma	3 to 5	4,200,000 to 7,000,000
5. Acute irritation symptoms	100	140,000,000
6. Decreased lung function in children	20++	28,000,000
7. Increased prevalence of chronic bronchitis	100	84,000,000
8. Increased acute respiratory diseases	100	140,000,000

*assumes 70% of 200,000,000 persons live in U.S. urban areas
+proportion of population aged 50 or more
**proportion of population aged 20 or more
++proportion of population aged 5 to 14

> (5) Alteration in function and structure of the respiratory epithelium of representative mammalian species has been demonstrated following exposure to a broad spectrum of these environmental irritants. The resulting changes appear to facilitate the biological action of carcinogenic agents; and,
>
> (6) Bioassay by skin-painting and subcutaneous-injection techniques has established the carcinogenic properties of compounds identified in and extracted from polluted air. Exposure of both susceptible and resistant strains of mice to aerosols of synthetically reproduced polluted urban air has resulted in lung tumors in both strains."

A further occupational hazard associated with the use of coal tar pitch is photosensitization. Combes, at New York University, states (25) that workers using coal tar as an insulating material developed an itching and dermatitis on areas of the skin exposed to the pitch after subsequent exposure to sunlight. Similar conditions exist at the Columbia Falls plant.

Recalling the results of the studies of PAH in Columbia Falls, etc., it seems appropriate to prevent the subjection of residents to the risks associated with exposures to PAH in the ambient air.

G. Animals

That atmospheric emissions of fluoride can culminate in significant damage to livestock has been well documented. It is generally accepted, also, that a major source of fluoride causing fluorosis in animals is not inhalation but ingestion of contaminated feeds and possibly water. The fluoride content of grasses, other feeds, and water may be the result of several sources of fluoride, including the soil. For example, fluorosis in cattle has been found in Tennessee with cattle fed on crops grown in high fluoride soils in an agricultural non-industrial area. Fluoride in the plants was due to wind blown dusts and splashing from heavy rainfall as opposed to uptake of the soil content by the plant.

Most studies regarding domestic livestock and the effects of fluoride on them have been done with cattle which exhibit a greater tendency to accumulate the fluoride and develop some type of fluorosis than do other livestock animals. The effect of fluorides on animals is much similar to that of the effects on man. The most susceptible portion of the population is the young--those with developing dentition and skeletal structures. The effects can be seen, however, in older animals, especially if they have been feeding on a contaminated forage for a long period of time.

Largely for these reasons, the state has adopted a standard for fluoride content of forage of 35 ppm (dry weight basis). Considerable amounts of vegetation in the area have accumulated in excess of 35 ppm, sometimes several factors of ten in excess of it.

Data are available on fluoride effects on wild herbivores; e.g., mule deer, whitetail deer, and rodents. Gordon (22) analyzed several animals collected around the AAC plant for the fluoride content in their bones. More than 650 animals were collected of which 95% were herbivores. He concluded that control species as a rule averaged fluoride in the femur bones of less than 200 ppm. The one exception was deer with an average level of 216 ppm; concentrations of fluoride in femur bones rarely exceeded 250 ppm in control animals. Of the 10 deer collected in the upper Teakettle Mountain area, during the study period, summer and fall of 1970, most were manifesting tooth damage and marked osteofluorosis of the femur bone. Mule deer and whitetail deer collected on lower Teakettle Mountain had fluoride contents ranging from a low of 370 ppm to a high of 7350 averaging 4168, and those collected on upper Teakettle had a low of 840 ppm, a high of 7150 and a mean of 3394. Generally it can be stated that fluoride content decreased with distance collected from the Anaconda Aluminum facilities. It is not surprising that, given the levels of fluoride found in some of the vegetation and considering that the indigenous animals have no outside feed supplements, fluoride levels are accumulating in the animals of the area.

Similar results were obtained from animals gathered in the Park and similar conclusions were drawn. Fluoride contents were lower but still high. Four Whitetail deer collected in Glacier Park averaged 1226 ppm F (high 2400, low 124) compared to the control animals (avg. 218, high 635, low 88).

These data dramatically illustrate the potential for damage, even the probability of current damage to wildlife residing under the influence of the AAC plant's emissions.

The data further indicate the need to establish the extent of damage occurring as a result of the plant's emissions, and then to ensure safe exposure and intake levels to avoid damage.

II. Vegetation

There is extensive agriculture carried on in the Flathead Valley. The mountainous environs exhibit a rich flora of predominately coniferous forests. Among the trees most common to the area are:

Douglas Fir, _Pseudotsuga menziesii_ (Mirbel) Franco
Ponderosa Pine, _Pinus ponderosa_ Laws
Balsam Fir, _Abies lasiocarpa_ (Hook) Nutt
Whitebark Pine, _Pinus albicaulis_ Engelm
Lodgepole Pine, _Pinus contorta_ var. _latifolia_ engelm.
Western Larch, _Lavix occidentales_ Nutt
Yew, _Taxus brevifolia_ Nutt
Juniper, _Juniperus occidentalis_ Hook
Western Red Cedar, _Thuja plicata_ Donn. Hort.

Common deciduous plants of the region include:

Paper Birch, _Betula papyrifera_ Marsh.
Mountain Maple, _Acer glabrum_ Torr.
Cottonwood, _Populus trichocarpa_ T and G., Ex. Hook
Aspen, _Populus tremuloides_, Michx.
Alder, _Alnus incana_ (L) Moench
Mountain ash, _Sorbus scapulina_ Greene (26)

Fluorides emitted by aluminum reduction processes have been a known hazard to vegetation for decades. Fluoride in gaseous form, and particulate fluoride dissolved by moisture are readily absorbed by plant foliage (27, 28). Once critical levels are absorbed, the appearance of damage will be apparent on needles of conifers or leaves of deciduous plants (29). Scientists have been studying the effects of fluorides on vegetation for years, so the effects are better documented than those of other pollutants.

A pear exhibiting typical fluoride damage symptoms was found near the AAC Plant. The tips and margin of leaves contain blackened dead (necrotic) tissue. This tip and marginal necrosis is a classic example of fluoride damage. On conifers fluoride damage appears as tip necrosis, with the dead tissue often separated from healthy tissue by a dark band (29). The damage symptoms occur in areas of the plant which have accumulated toxic quantities of fluoride. Once absorbed, the fluoride migrates to the tips and margins of the leaf. When fluoride analyses were conducted on this pear leaf tissue, a concentration of 53.6 ppm was found. This is in excess of the state standard of 35 ppm. This pear tree is situated within a mile of Anaconda Aluminum. Additional analyses of fluoride in vegetation around the Columbia Falls plant have yielded fluoride levels of as high as 1032 ppm in grass and 763 ppm in conifer samples. These levels are as much as 30 times that of the state standard.

Both Anaconda Aluminum and the Air Quality Bureau, in addition to others, have conducted surveys of fluoride accumulation in vegetation. Table 15 includes vegetation data from analyses conducted by Anaconda Aluminum. The data has been segregated into pine and grass fluoride readings. What is represented are four years of seasonal data; 1970-1973, corresponding to collection sites located at various distances from the Anaconda Aluminum Reduction Plant. The same sites were used from season to season over the four year span of this study. Note that the value corresponding to a particular season and distance from the plant is a mean for several collected samples. For example, the 17.20 ppm with an asterisk under the summer 1973 column is the mean ppm fluoride for five pine samples collected within one mile of the plant. A separate row B indicates the number of samples in violation within the seasonal sampling, while row C indicates the two peak readings among the seasonal samples. Thus for the summer of 1970, 6 out of 22 pine samples were above the state standard of 35 ppm F. At the same time within these 6 violations, the two peak readings were 107 and 72 ppm. Excessive

TABLE 15

Anaconda Aluminum Vegetation Data

Mean of Several Sites Per Mile Distance From Aluminum Reduction Plant

			1970			1971			1972			1973	
Distance		Spr	Sum	Aut	Spr	Sum	Aut	Spr	Sum	Aut	Spr	Sum	Aut
1 mile	Pine		42.1	53.5		24.2	47.2		18.6	40.4		17.2	
2 mile	Pine		33.5	52.16		23.0	48.0		14.0	21.66		7.6	
3 mile	Pine		19.83	28.37		8.0	18.66		4.5	15.6		4.5	
4 mile	Pine		8.17	13.67		6.0	14.67		8.33	10.33		4.0	
5 mile	Pine	37.0	7.0	9.17		5.67	8.0		3.33	9.67		3.3	
7 mile	Pine		4.0	6.0		4.0	4.0		0	3.00		1.0	
9 mile	Pine		4.0	8.5		9.0	7.0		2.0	4.0		3.0	
Total # Violations/ Samples Collected		1/1	5/22	7/21		4/22	7/22		2/20	4/21		1/22	
Peak Readings			107 72	131 90		42 42	88 77		38 31	77 56		31 23	
1 mile	Grass		122.6	233.5	68.8	151.4	149.6	53.4	125.2	268.25	47.8	83.8	
2 mile	Grass	22	71.83	75.25	31.67	60.0	92.0	30.5	35.67	106.33	18.67	24.0	
3 mile	Grass	12.5	27.7	41.0	15.5	23.0	48.17	10.33	7.67	32.4	6.67	14.5	
4 mile	Grass	20.5	22.83	29.0	22.67	26.67	67.0	7.67	7.67	27.0	6.67	18.33	
5 mile	Grass	10.0	24.67	40.33	9.67	16.0	44	3.67	13.33	18.33	3.33	9.67	
7 mile	Grass	9.0	24.5	45	19	22	17	6	13	29	6	15	
9 mile	Grass	7	14	33	8	22	13	3	2	9	4	9	
Total # Violations/ Samples Collected		0/10	7/22	12/20	6/22	8/22	11/18	5/21	6/22	10/20	2/22	7/21	
*X determination of ppm F in vegetation sample													
Peak Readings		31.0	206 189.5	413.5 356	161 57	220 180	262 170	95 69	236 198	755 241	112 71	129 114	

levels continueto occur in samples collected, though this data shows a lowering of F levels in vegetation over the 4 years.

Data of the Air Quality Bureau is shown in Figure 4. Thirty-four conifer samples were collected in May of 1973 at sites ranging up to 4 miles from the Columbia Falls Plant. When this data is compiled and plotted on a graph the impact of gaseous and particulate fluoride on the area surrounding the plant is seen. The Y axis of this graph represents distance from the Anaconda Aluminum Reduction Works while the X axis represents ppm fluoride. The X axis is also entered in logarithmic increments of 10, 100, 1000 ppm, merely to reduce the space on the graph necessary to plot the excessively high readings occurring quite close to the plant. The number of violations per total samples is entered at each point on the graph. Also, the state standard of 35 ppm for forage has been entered. Viewing the graph it becomes immediately clear that fluoride level is in excess of the state vegetation standard up to 3 miles from the plant. This is evident by the profusion of fluoride damage symptoms present on vegetation surrounding the plant. Peak readings of 763 ppm F at one mile and 180 ppm F at two miles from the plant serve as illustrations of the excess of the state fluoride standard being found in vegetation samples. The graphs do not present data in a specific direction from the plant but are averages of all samples collected at a particular distance.

The state's findings agree well with those of Carlson (26) who reported excessive levels of fluoride within four miles of the aluminum plant. Carlson, working for the U. S. Forest Service, set up vegetation sampling plots on 10 radii extending up to eight miles from the plant. The samples were collected in June-July and October-November of 1970. The sample included grass, herbaceous plants, and conifers. The analytical work done on these vegetation samples included analyses of fluoride in tissue, and histological preparations of damaged cells. Results of this study indicate that excessive levels of fluoride existed up to four miles from the plant. However, damage symptoms were evident on vegetation up to 8 miles from the plant.

SDHES CONIFER SAMPLES

Superscript indicates number violations/ total samples.

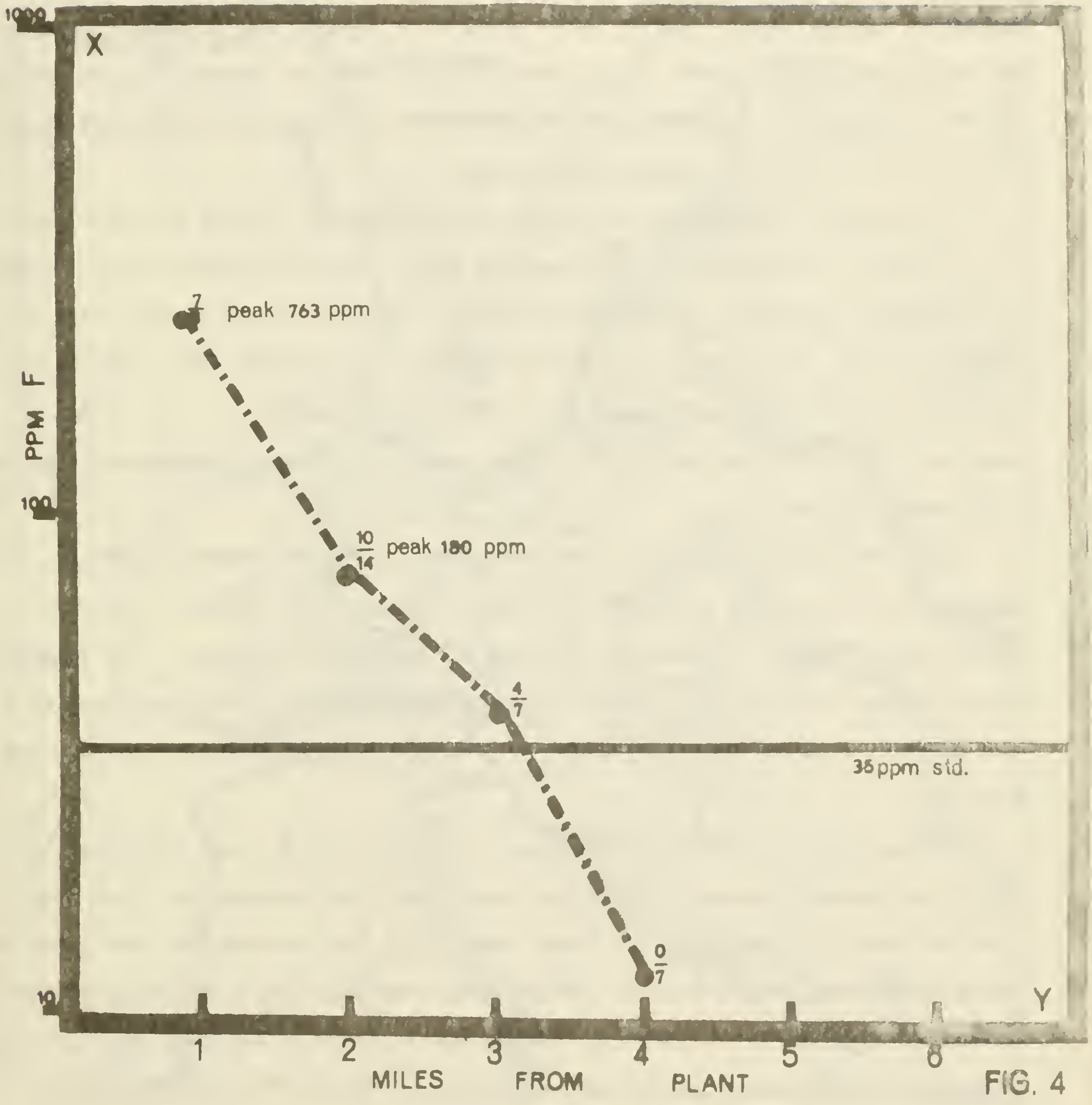


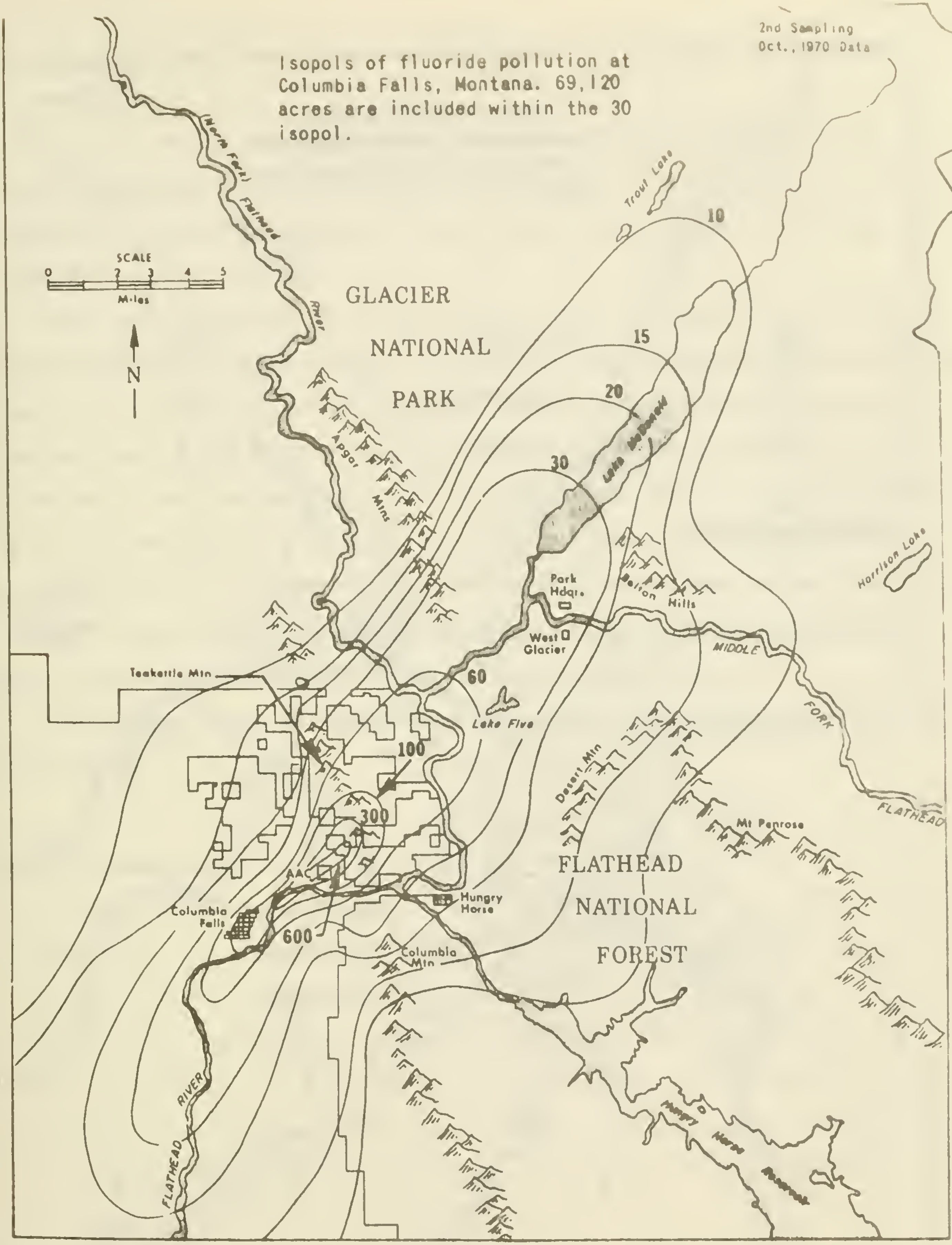
FIG. 4

When Anaconda Aluminum reduced their fluoride emissions in 1970-1971, Carlson monitored the vegetation again in 1971 (30). A comparison of Figures 5 and 6 will illustrate Carlson's findings. The average plot fluoride concentrations were determined. Lines (isopols) were drawn to encompass areas containing fluoride levels equal to or greater than the values indicated. Thus the 60 isopol includes plots with vegetation samples having fluoride levels equal to or greater than 60 ppm. Comparing the two figures it is apparent that a reduction in fluoride emissions did occur within the two year period of the study; however, excessive fluoride levels were still present within a four-mile distance from the plant.

The plots also show the effects of the prevailing winds on plant emissions. In his 1971 study of fluoride in Glacier National Park, Gordon (22) reported that increasing accumulations of fluoride occurred in pine needles ranging from one to four years of age. Though the current year's needles of Ponderosa and Lodgepole pine trees did not exceed the 35 ppm fluoride level set by the state, the four year old needles did. Levels as high as 49.8 ppm were found in 1968 needles of Lodgepole pine from the Belton Hills zone of the park.

These studies furnish lines of evidence from four sources; Anaconda Aluminum Company, State Department of Health, Air Quality Bureau; Clint Carlson of the U. S. Forest Service, and Dr. Clarence C. Gordon of the University of Montana. The vegetation data incidates that excessive levels of fluoride and extensive damage from fluoride area present in vegetation within a four to five mile distance from Anaconda Aluminum Plant.

At present no survey of fluoride damage to crops in the Flathead Valley has been made. The excessive amounts of fluoride found within other studies may affect both yield and quality of vegetable and forage crops (31). Such studies have been conducted in other states and much financial loss has been documented (32). Beyond agricultural economics, these excessive levels of fluoride pose a hazard to the plant and wildlife communities of the upper Flathead Valley and Glacier National Park, perpetuating a persistent decline in the state of the environment.



Isopols of fluoride pollution at Columbia Falls, Montana. 69,120 acres are included within the 30 isopol.

2nd Sampling
Oct., 1970 Data

FIGURE 5

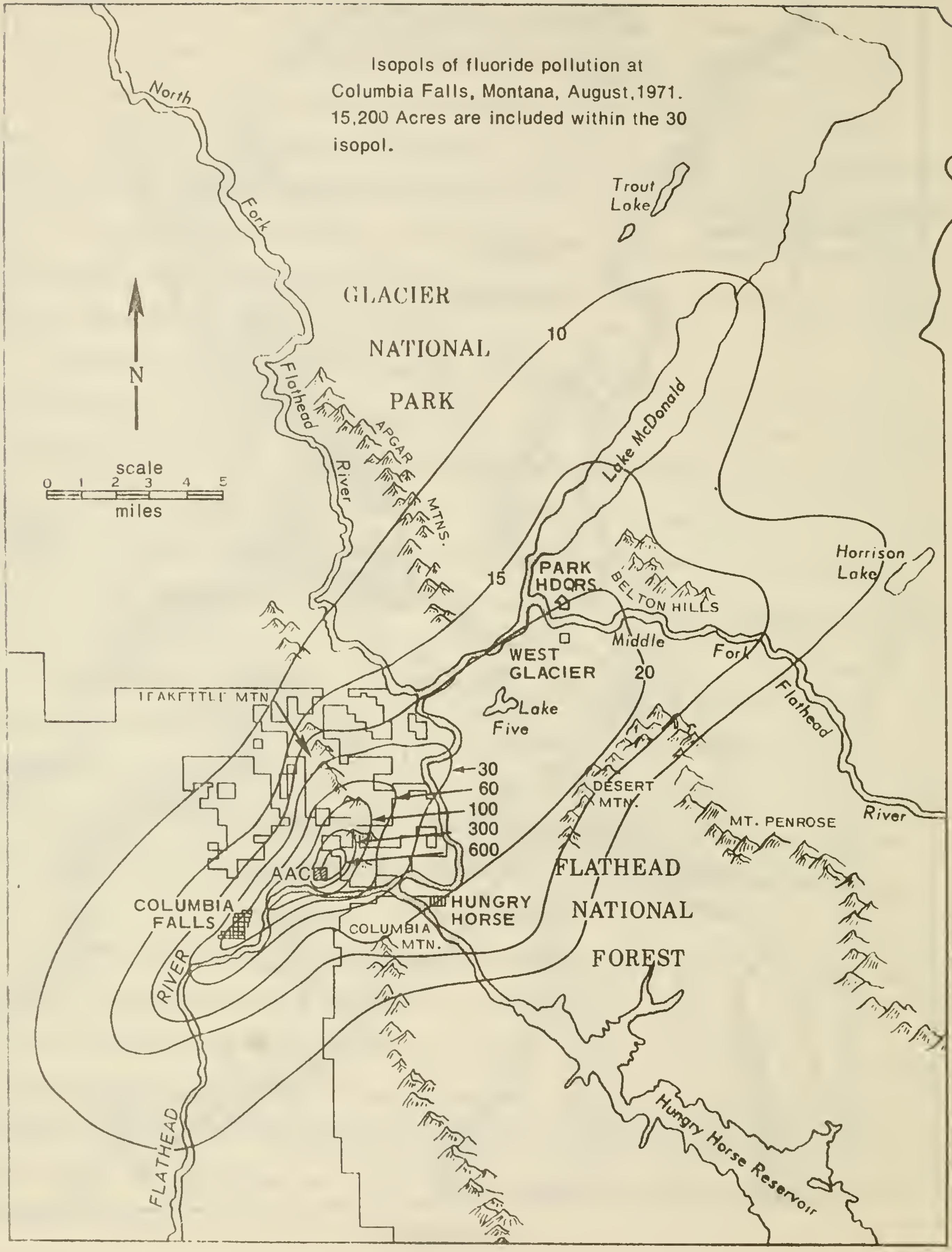

Isopols of fluoride pollution at
Columbia Falls, Montana, August,1971.
15,200 Acres are included within the 30
isopol.
North Fork
Flathead River
GLACIER
NATIONAL
PARK
APGAR MTNS.
N
scale
0 1 2 3 4 5
miles
Trout Lake
Lake McDonald
10
15
20
30
60
100
300
600
PARK HDQRS.
BELTON HILLS
Horrison Lake
WEST GLACIER
Middle Fork Flathead River
Lake Five
TEAKETTLE MTN
DESERT MTN.
MT. PENROSE
AAC
COLUMBIA FALLS
HUNGRY HORSE
COLUMBIA MTN.
FLATHEAD
NATIONAL
FOREST
FLATHEAD RIVER
Hungry Horse Reservoir

FIGURE 6

Additional data from the above mentioned studies are included in Appendix C.

I. Visibility

Fluorides per se have no significant effect on visibility except as they are found as particulates. Particulate matter has certain effects on visibility. In the Columbia Falls area, visibility is affected by sources of particulate matter, in addition to Anaconda Aluminum.

There are some significant differences in the data and figures used in AP-49 and what is applicable to Columbia Falls. Some of the particulates emitted from the aluminum plant are hydrocarbons driven off the anodes. These hydrocarbons result in the blue haze seen issuing from the roof lines above the plant. At times, the haze can result in noticeable deterioration in visibility especially near the plant. This phenomenon is most pronounced during periods of atmospheric stability (inversion). The effect is reinforced by other sources of particulate matter, such as tepee burners, boilers, and dustry roads. See HEW publication, Air Quality Criteria for Particulate Matter, AP-49, National Air Pollution Control Administration, 1969, Chapter 3.

The National Weather Service observes and records visibility at the airport. See Table 16.

TABLE 16

Days When Smoke Reduces Visibility in Flathead Valley to 6 Miles or Less

Data Taken at Glacier Park International Airport

	65	66	67	68	69	70	71	72	73	Total
Jan.	0	0	0	1	1	4	1	1	0	8
Feb.	3	4	0	NR	15	6	3	3	0	34
March	0	0	0	0	10	4	0	0	0	14
April	0	0	0	1	1	1	1	1	0	4
May	0	0	0	0	0	1	1	1	0	3
June	0	0	0	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0	0	0	0
August	0	0	3	0	0	1	1	0	0	5
Sept.	0	0	0	7	1	6	0	0	0	14
Oct.	2	6	4	10	11	10	5	9	0	57
Nov.	3	2	5	5	8	8	2	7	0	40
Dec.	2	1	0	1	7	2	0	1		14
	10	13	12	25	54	43	14	22		

J. Energy

Much of the following information has been obtained from Bonneville Power Administration as of October 1, 1973. For the Pacific Northwest, firm load requirements for 20½ months are estimated to be about 200 billion kilowatt hours, or about 14,000 average megawatts. As of October 1, there existed a deficiency of about 14 billion kilowatt hours or about 7.4% of the firm requirements. This has been reduced somewhat because of the rain and snowfall; in addition the energy conservation measures in the Pacific Northwest have also reduced the demand. Interruptible power supplied to industry was curtailed on April 11 from 1140 megawatts to 520 megawatts, reduced again on July 20 to 260, then to 220 megawatts. Energy consumption by Anaconda Aluminum varies, of course, according to production. For 1972 consumption was 8,796,000 KWH daily; 268,265,000

KWH monthly, and for the whole year, 3,219,175,222 KWH. The daily figure is equivale to an instantaneous value of 366.5 megawatts. According to the BPA, at full production full demand, Anaconda demands 372 megawatts of electric energy. This is equivalent to 2 plants the size of the Montana Power's J. E. Corette Plant in Billings or about the same size as one of the steam electric generating units being installed in Colstrip, Montana.

K. Raw Materials

The basic raw materials for the process are alumina, cryolite, aluminum fluoride, carbon and electricity. The electrical energy has been previously discussed. Table 5 (Section II) lists all the materials involved and amounts used, with raw materials given in the first part of the table.

As a point of reference, Anaconda Aluminum is credited with having 3.78% of U.S. aluminum production capacity in 1971 and 1.52% of total world production capacity (10). Percentage involvements in the use of other materials are correspondingly small. In the cases of raw materials, especially alumina and cryolite, both of which are used for more than aluminum production, AAC's influence on markets is even less significant.

L. Water Quality

The Flathead River is the major water course in the area which at Columbia Falls consists of the North, Middle, and South Forks of the Flathead River. At the entrance to Flathead Lake, flows from Whitefish Creek and the Stillwater River have been added. The Flathead is part of the PendOreille River Basin and at Columbia Falls has a drainage area of 4,464 square miles.

Average discharge at this point (43 years data) is 9,712 cubic feet per second (CFS) or 7,036,000 acre feet per year. Average for October, 1970 to September, 1971 is 9116 CFS. Flows have been adjusted for Hungry Horse Reservoir draw-down. Minimum flows observed have been 798 CFS on December 8, 1929 and for the above period 1,550 CFS on November 4 and 5, 1970 (33).

The quality of the river at Columbia Falls is fairly good. Average fluoride content of the water is 0.3 ppm at Columbia Falls and 0.11 ppm at Bigfork (34). Average concentrations of naturally occurring fluoride in surface water ranges from 0.02 ppm to 0.1 ppm in the Northeastern U. S. to over 0.2 ppm in the midwestern and western states (21).

AAC neither withdraws nor discharges water from the river at present. Plant water supply is from wells, located on company property, capable of producing 5600 GPM compared to the river 900,000 GPM at low flow. Well depths range from 60 to 175 feet and drawdown is from 2 to 16 feet at maximum production. The nature of the river bed and underlying alluvial gravels and depth of wells indicate that they are recharged by the river. Plant cooling water is held in a seepage pond and scrubber water is treated and recirculated through the system, with makeup for evaporative losses

V. POSSIBLE ACTIONS BY DEPARTMENT

The only two alternatives available are granting or denying the variance request. The State Board of Health and Environmental Sciences has statutory authority to allow variances only if present emissions are no danger to the public health and no hazard to the public safety and, further, if the control of these emissions would produce more hardship than benefit to the public. The actions available to the Department of Health are in the form of a recommendation to the Board as to the disposition of the variance request. A denial of the variance implies that the Department should enforce the regulation in effect. The AAC plant's emissions are clearly in violation of the regulations.

VI. IMPACTS OF POSSIBLE ACTIONS

A. Granting Requested Variance

Any analysis of the impacts of granting the variance as Anaconda Aluminum has requested would be hypothetical as no definite plan for emission control has been proposed. This lack of a definite proposal creates too much uncertainty as to future emissions for the state to risk such a course. A reasonable inference is that emissions will not be any greater than they are now. The success or failure of the project and the whim of Anaconda Aluminum at least according to the proposal, would dictate future emissions. Continued emissions at present levels are intolerable for the public health and safety. If the petitioner were to control its emissions successfully by treating all of the emissions from the plant through the "Foamator" process, then that would mean compliance with the existing regulations. The effect would be nearly the same as action taken by the state to achieve compliance with the existing regulations. The only difference would be in the time required to achieve such compliance.

Given the above conditions, impacts can best be summarized very succintly: little change in current situations and trends. The net result would be insignificant change in emissions and a continuation of present trends and situations. Cumulative effects of such continuing pollution would produce far more hardship to the public than benefit if any.

Air Quality, Visibility, Human Health

The population would continue to be subjected to potentially hazardous carcinogenic agents; to high levels of short-term suspended particulate; and to the accumulation of fluorides. A continuing air pollution control program by the state is expected to reduce suspended particulate levels and lessen visibility reduction caused by air pollution but Anaconda Aluminum would remain an unmitigated major contributor. Questions as to the hazards or potential hazard to residents should not be resolved at their peril.

Vegetation

One of the most certain effects of continued plant emissions would be the continued accumulation of fluorides in vegetation and a continuation of damages in Glacier National Park and areas surrounding the plant.

Anaconda Aluminum's present emission level is very likely to bring about an eventual change in the types and frequencies of plants growing in the area. Continued fluoride emissions would be expected to eliminate certain sensitive plants from the forest community. At the same time resistent members of the plant community could replace the sensitive plants. For example, junipers growing in stands along with more sensitive Ponderosa pine and larch would be expected to increase in numbers. The same might occur with resistent strains replacing intermediately sensitive aspens around stream banks in the area. (29) Changes in plant communities in the area should not be treated lightly; as one must consider that the stable plant community found prior to operation of the aluminum plant took thousands of years to develop.

Animals

The accumulation of fluorides in the vegetation creates a very real potential for damaging accumulation in animals. This is occurring now. A potential for ecological damage exists but the magnitude of the potential effects is unknown.

Economics

The economic situation would be considered unchanged by such an action, and continue to be dependent largely on other factors such as the energy crisis, the state of the economy, the price of aluminum, etc. Social factors are likewise expected to be largely unaffected by this action on balance.

Energy, Raw Materials, Water Quality

Granting the variance as requested would have no direct effect on energy consumption. The current power situation may affect the aluminum plant adversely because of the nature of Anaconda Aluminum's power contract with BPA. Within certain limitations BPA can reduce electricity supplied to Anaconda Aluminum should the need arise. In fact, Anaconda Aluminum has already been curtailed by the amount of interruptible power available. Anaconda Aluminum is 26% curtailed at present, and one potline 20% is completely shut down. At full production Anaconda Aluminum has a demand of 372,000 KW with 88,000-90,000 KW of interruptible and 284,000 KW of modified firm power. According to Anaconda Aluminum during 1972 total average demand was about 367,000 KW with 11,500 KW of that being used for non-production purposes.

Water Quality and Raw Materials

Adverse impacts on the quality of the water are not expected. Predictive techniques for assessing air emissions and resultant quality of water are essentially non-existent. No significant effects have been observed.

No effects should be seen on the consumption or disposition on process raw materiala or natural resources other than those discussed.

B. Denying the Variance

If the variance were denied the plant would remain in violation of the regulations as they are now. But ANaconda Aluminum would no longer be subject to the stay of enforcement granted by the state during the duration of the variance proceedings.

1. Compliance with the regulations.

There is no action by the state which could result in immediate compliance by AAC, as a time lag would exist for construction of a system. Substantive differences from AAC's proposal could be that the state would be requiring: (1) a firm commitment for control of all emissions (2) a specific program for the research with provisions for alternative methods should the foam scrubber not prove feasible; and (3) a specific time schedule to achieve compliance. Such requirements would make note that there are technologies available to control the emissions other than by what Anaconda Aluminum is proposing, but would acknowledge that the foam scrubbing system has some merit and shows some promise.

Air Quality, Visibility, Human Health, Vegetation

The probable impacts of such an action would be an improvement in air quality, reduction in both damage and accumulation of fluorides in the area, vegetation, reduction of possible hazards from suspended particulate and carcinogens, improved visibility in the area with minimal economic disruption to the area. In fact, economic benefits may occur due to the slightly increased manpower that would be required. In regard to air quality control, a proposed standard of 8.65 lbs of particulate matter/ton of aluminum would necessitate approximately a 45% reduction of particulate emissions. This would reduce total particulate emissions from about 8,000 lbs/day to 4,000 lbs/day or from 16 to 8 lbs/ton. Fluoride emissions would be reduced to 864 lbs/day or approximately 1.73 lbs/fluoride/ton of aluminum produced. These figures are at full production. Some damage to vegetation probably will still occur even with the reductions but there most probably would be an elimination of further accumulations at Glacier National Park.

Energy

Some additional energy would be consumed for operation of the secondary air pollution control system. Literature data indicate that from 230-455 KWH per ton of aluminum are consumed by the secondary systems. Estimates are difficult to prepare due to variations in design, climate, control efficiency and other factors, but they do provide some indication. At Anaconda Aluminum this would amount to from 41 to 82 million KWH per year or an increase of 1.2 to 2.5% of AAC's full production in annual use. Such an increase in electrical demand for these low power air pollution control systems would be considered by the Department to be far outweighed by the significant reduction in the emission of air pollutants, especially the fluorides and polynuclear aromatic hydrocarbons.

Water Quality & Hydrology

Direct impacts on stream quality are not expected as a result of any action the Board might take. Water quality standards and proposed effluent discharge standards will prevent significant quantities of any pollutant from being discharged to the stream.

Moreover, the state has a stream "non-degradation law" which prevents a discharge which causes any measurable increase in contaminant concentrations. As previously mentioned, Anaconda Aluminum has no direct discharge but in all probability seepage from the ponds goes directly to the rivers. No changes are forecast in this method as the state water quality engineers consider the treatment quite good. There exists a possibility of water pollution problems from the foaming agent in AAC's foamator. Many organics are highly toxic to aquatic life but the toxicity of the foaming agent is unknown. Before AAC could utilize such a system, therefore, water hazards would have to be studied. If such hazards were found to make the "Foamator" process intolerable, then that finding would be one reason to require AAC to employ some other existing control technology. Hydrological impacts of any proposed action also are expected to be insignificant. Maximum production from the wells could conceivably reduce total stream flow by a maximum of 0.62% if none was returned. This is the extreme case and is not probable. Anaconda Aluminum should achieve a closed system for scrubber water or 100% recirculation of process waters. This in practice is not achievable as some will be lost by evaporation at the scrubbers and possibly some at the treatment facility. Evaporation losses from the secondary scrubbers should be low, 30 gallons per minute, as inlet gases are fairly cool, about 30°F above ambient temperature. Some idea of the magnitude of losses might be obtained by comparison with the primary system. For the whole plant the primary system treats about 360,000 SCFM of air at 300°F. Water rates are 1500 GPM Total, with a 150 GPM makeup. A secondary system might treat 2.5×10^6 SCFM at about 70°F the total water rate of 600 GPM. Evaporative losses should not exceed 10% or 60 GPM.

2. Plant Closure

Benefits to be obtained by closure of the plant would be significant in terms of emission reduction and the corresponding reduction of pollutant levels in the ambient air. This would most assuredly result in a cessation of the accumulation of fluorides in vegetation and would eliminate the hazards of adverse effects to animals and man. Glacier Park would no longer experience the damage caused by fluoride levels. Increases in visibility could be expected and large amounts of electrical energy would be releas for other uses. Assigning dollar values to such benefits is highly subjective. Currently there are damage suits filed against Anaconda Aluminum requesting payments of approximately 3.5 million dollars. Recent Forest Service studies have shown that timber losses alone due to damage from the plant's emissions may approach hundreds of millions of dollars.

The most severe and probably the most obvious adverse consequence of closing the plant would be the economic impact on the immediate area. Loss of payroll, tax payments, increase in unemployment and welfare and decline in the auxiliary services required would be expected. The dollar values of these effects are subject to numerous variables but obviously would be considerably more severe in the immediate area than the whole state. Effects on the world or U.S. production of aluminum metal should not be significant given the figures previously mentioned. If we assume the values provided by Anaconda Aluminum in their variance petition are correct, and they appear to be, payroll from the plant is approximately $9.5 million per year with a current employment of 911 people. A recently released report by the Department of Intergovernmental Relations puts Montana earnings for 1973 at about $2.1 billion, with approximately 283,000 employees. Property tax payments on the Columbia Falls plant are about 1.38 million dollars or 14.4% of the property tax revenue in Flathead County.

Plant closure in the Department's opinion is a remote possibility in any case. Experience with other industrial pollution sources including aluminum companies compels the conclusion that plant closure is dictated by corporate economics, not by pollution control.

Existing technology permits the installation of pollution control systems at AAC for cost commensurate with what other aluminum companies have (voluntarily and involuntarily) expended on no greater investment base than AAC's.

The Anaconda Company's annual report for 1972 contains detailed financial data for the entire company but rather general data for the AAC division.

The following table summarizes the data for the AAC Division and the Company as a whole.

TABLE 17

Financial Data

	1972	1971
AAC		
Sales as % of total Company sales	19.6%	16.3%
Sales	$198,434,000	$184,093,000
Anaconda Company		
Expenditures for additions to plant and equipment	122,599,000	89,885,000
Assets in buildings, machinery, equipment	1,249,718,000	1,162,062,000
Net Income (Loss)	133,037,000	(353,844,000)

VII. ANALYSIS OF DEPARTMENT'S PROPOSED ACTION

Based on the information previously presented, and the criteria for decision making, it is the Department's position that the interests of the state would best be served by denying the variance requested. The need to control the emission from the plant has been clearly established. The emissions from the plant, fluoride and particulate, have extensively damaged vegetation and continue to do so. There is a real potential of subjecting people, and certainly wildlife, to the risk of adverse effects associated with the air pollutants.

To what level the emissions should be controlled may be subject to some debate but the guiding precept of public health work has been and will continue to be to err on a side of overprotection until it can be affirmatively demonstrated that such overprotection is unnecessary. Indeed, the Clean Air Act of Montana declares as policy the achievement of air quality that will protect human health and safety and as much as possible "prevent injury to plant and animal life and property, foster the comfort and convenience of the people, promote the economic and social development of this state and facilitate the enjoyment of the natural attractions of the state." When data are lacking or inconclusive, prudence dictates that exposure be minimized until it is proven that higher levels of exposure can be safely tolerated rather than "torture testing" or permitting higher levels until it can be conclusively shown that they are lethal or "at least" harmful.

Consistent with these policies, the air pollution control program in the state of Montana has promoted and should continue to encourage and in many cases require the use of the most advanced technology available for the control of air pollutants. The existing fluoride regulation and the proposed particulate regulation are consistent with these policies. Existing technology would achieve compliance with the regulations.

AAC in essence has requested that the state share in the risk of research for emission control with no promise of compliance ever. There exist means to achieve the compliance without risk.

The environmental impacts of granting the AAC request preclude it as a viable option.

Denying the variance is a far more desirable course, for the probable adverse effects are minimal. Denial of the request would put the plant in violation of the regulations, release the parties from the stay of enforcement and perhaps necessitate action by the state to abate the unlawful emission. This action is likely to result in abatement of the emission through application of existing emission control technology and would achieve compliance at what appears to be a reasonable cost.

The Department is obligated to consider the effects of its action on the whole state. Therefore, the Department will recommend denial of the variance.

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APPENDIX A
VARIANCE PETITION, RULES

PETITION FOR VARIANCE
FROM CERTAIN RULES AND REGULATIONS
TO
THE DEPARTMENT OF HEALTH
AND ENVIRONMENTAL SCIENCES
AND
THE MONTANA STATE BOARD
OF HEALTH
BY
ANACONDA ALUMINUM COMPANY DIVISION
OF
THE ANACONDA COMPANY

Introduction

The Anaconda Aluminum Company Division of The Anaconda Company ("Anaconda Aluminum") hereby petitions the Montana State Board of Health to grant Anaconda Aluminum's reduction plant located at Columbia Falls, Montana, a one-year exemption under Section 69-3916 of the Revised Codes of Montana from compliance with the fluoride and particulate regulation set forth in §16-2.14(1)-S14080 of the Montana Administrative Code, and from §§16.2.14(1)-S1430 and S1460 to the extent they may be applicable directly or indirectly. During the one year period Anaconda Aluminum proposes to continue its efforts to develop technically and economically feasible solutions to further control its emissions from the Columbia Falls aluminum reduction plant, including in particular the purchase and installation of a foam scrubbing equipment pilot unit. If pilot tests prove technically and economically satisfactory such equipment will be installed on sixty feet of one roof line and, again assuming successful operation, additional units would be installed toward achievement of Montana's emission standard.

In short, Anaconda Aluminum is seeking additional time in order to develop technology which will meet Montana's air pollution control regulations. However, in doing so, Anaconda Aluminum emphasizes that no aluminum company in the world has yet developed a technology for vertical stud Soderberg aluminum reduction plants which will meet Montana's fluoride and particulate regulation for aluminum reduction plants. Anaconda Aluminum can give the Board no absolute assurance that it will be able to do so.

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I. INFORMATION REQUIRED FOR VARIANCE REQUESTS.

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III. APPLICABLE MONTANA AIR POLLUTION CONTROL REGULATIONS.

IV. HISTORY OF AIR POLLUTION CONTROL PROGRAM AND EQUIPMENT.

V. PROPOSED ADDITIONAL AIR POLLUTION CONTROL EFFORTS.

VI. NO HARM TO PUBLIC HEALTH OR SAFETY WILL RESULT FROM GRANTING THE VARIANCE.

VII. ADVANTAGES AND DISADVANTAGES RESULTING FROM GRANTING OR DENYING THE VARIANCE.

I. INFORMATION REQUIRED FOR VARIANCE REQUESTS.

The information required by the guidelines for requesting a variance is as follows:

A. The company's name, address and telephone number are:

The Anaconda Aluminum Company Division
of the Anaconda Company
1251 South Fourth Street
Louisville, Kentucky 40203
Telephone No. (502) 634-1511

The person authorized to receive service of notice at this address is Krest Cyr, Esq., Vice President and Council.

We would also like to request that notices be sent to:

Mr. E. O. Woster, Plant Manager
The Anaconda Aluminum Company
Columbia Falls, MT

and

Robert T. Connery, Esq.
500 Equitable Building
730 - 17th Street
Denver, Colorado 80202

B. Petitioner is a Montana corporation and the names and addresses of its principal officers are as follows:

Name	Title and Address
John B. M. Place	Chairman of the Board, President and Chief Executive Officer 25 Broadway New York, New York 10004
Joseph B. Woodlief	Vice President 1251 South Fourth Street Louisville, Kentucky 40203
Krest Cyr, Esq.	Vice President and Counsel Aluminum Division 1251 South Fourth Street Louisville, Kentucky 40203
E. O. Woster	Plant Manager Columbia Falls, Montana

C. Petitioner's business or activity involved in this application is its aluminum reduction works located near the town of Columbia Falls, Montana.

D. The description of the process carried on at the plant is contained in paragraph II below.

E. The regulation involved in the application is Montana Administrative Code §16-2.14(1)-S14080 of the Department of Health and Environmental Sciences, and, to the extent they may be applicable indirectly and directly, regulations 16-2.14(1)-S1430 and 16-2.14(1)-S1460 of the Department of Health and Environmental Sciences.

F. The facts which show why compliance with the regulations would not be reasonable are discussed below under paragraphs IV, V, VI and VII.

G. The damage or harm which result to petitioner from compliance with the regulations are discussed below under paragraph VI.

H. Petitioner could presently meet an emission requirement of 2,500 pounds per day of fluorides in gaseous and particulate form from its Columbia Falls plant as a whole.

I. The advantages and disadvantages to the residents of the state resulting from requiring compliance or resulting from granting the variance are discussed below under paragraph VII.

J. Petitioner's operations do not constitute a nuisance.

K. Several individual damage actions are currently pending against the petitioner's Columbia Falls plant, primarily for trespass. These claims aggregate approximately $3.5 million for compensatory and penalty damages.

L. The modifications made to the thirty scrubbers described in paragraph III below are covered by a permit to operate issued by the Board. The other equipment and processes at the plant are not subject to the Board's regulations requiring permits to construct or operate since they were installed prior to the adoption of the Board's regulations.

II. DESCRIPTION OF OPERATIONS.

The Columbia Falls plant of Anaconda Aluminum is engaged in the reduction of alumina to aluminum by the electrolytic smelting process. The plant consists of 600 electrolytic cells or "pots." There are 120 pots in each pot line, which consists of two rows of 60 pots each under a roof approximately 1,100 feet long. There are 10 pot rooms at the Columbia Falls plant with a total roof line of approximately 2 miles and 220,000 square feet of roof line ventilation for the emissions of the process. Electricity is the primary energy source for the plant and 100,000 amperes are fed through each pot in the electrolysis of alumina to aluminum. In addition to the pots, there is a plant for making carbon paste, a casting plant, and the usual auxiliary services including a laboratory, warehouse, machine shop, electrical substation, and administrative offices. The plant has a capacity of 180,000 tons of aluminum per year.

The basic unit of production is the vertical stud Soderberg electrolytic reduction cell. The cell consists of an anode, cathode, molten electrolyte, molten aluminum, electrical bus system and gas collection equipment. The anode consists of a steel shell which holds the anode paste mixture. The anode carbon paste is a mixture of coal tar pitch and coke which is prepared in the paste plant under specified conditions. The cathode is a steel shell which is lined with brick, alumina, prebaked carbon blacks and cathode paste. The electrolyte or bath is molten cryolite and aluminum fluoride.

The electrolysis of alumina into aluminum produces fluoride and particulate matter. At the Columbia Falls plant at present gas and particulate matter are captured from the pot to the maximum extent technologically possible and vented through a gas burner and scrubbe system which operates to remove approximately 98.5%-99% of the fluoride gas and particulate matter. The fluoride gas and particulate matter which are not captured by the venting system are drawn by natural draft through the roof ventilation system.

The molten aluminum in the pot resulting from electrolysis is drawn from the pot at regular intervals by the use of mobile vacuum crucibles, and transported to the casting plant where it is placed in one of the eight holding furnaces. These furnaces are gas fired with a back up of propane in case of emergency. The molten aluminum is then cast from the holding furnaces into water cooled molds of various sizes and shapes depending upon the product desired.

III. APPLICABLE MONTANA AIR POLLUTION CONTROL REGULATIONS.

The emissions from aluminum plants are specifically regulated by Regulation 90-019 (Montana Administrative Code, §16-2.14(1)-S14080) which provides that fluoride shall not be emitted in excess of 0.060 pounds per hour per reduction cell commonly called a "pot." As applied to the Columbia Falls plant this regulation results in an emission limitation of 864 pounds of fluoride per day. THe regulation also provides that all particulate matter including particulate fluoride emitted from all of the pot rooms combined shall not exceed that allowed under MAC 16-2.14(1)-S1430 (the so-called "process weight" standard) or MAC 16-2.14(1)-S1460 (the Ringlemann No. 2 standard). Depending upon whether the "process" or operation under the process weight regulation is interpreted to be each pot or all pot rooms combined, the regulation may call for a limitation of between 1,188 pounds per day and 16,128 pounds per day.

IV. HISTORY OF AIR POLLUTION CONTROL PROGRAM AND EQUIPMENT.

An active air pollution control program has existed from the beginning of the plant's design and operation in 1955. Anaconda technical personnel studies various types of aluminum reduction plants in the United States, Canada, and Europe and concluded that the vertical stud Soderberg ("VSS") cell would provide the use of the best available technology at that time for the production of aluminum and for the collection and treatment of off gases.

When the plant commenced operation in 1955 all pots were equipped with skirts for capturing the gases. In addition, ducts, fans and multiclones were installed for removing particulates and fluorides. THirty scrubbers were installed for removing fluorides The hydrofluoric acid resulting from the scrubbing was neutralized by lime. No industrial water effluent has ever been or is discharged from the plant into any stream. The cost of the air pollution control equipment for fluorides and particulates in the 10 pot rooms initially was $5,960,032. An additional $1 million has been spent for testing and research relating to air pollution control efforts. $125,000 has been spent on equipment for testing and monitoring. Maintenance efforts related to air pollution control currently run approximately $1 million per year. THe control level achieved with all of these air pollution control efforts and expenditures by 1969 was an emission of approximately 7,500 pounds per day from the plant of fluorides in gaseous and particulate form.

In 1969, Anaconda Aluminum undertook an intensive, thorough and exhaustive study of the collection and treatment system to improve to the maximum extent technically possible the control of its emissions of fluoride and particulates. At a cost of over $1 million the company has succeeded in reducing its emissions from the 1969 level of 7,500 pounds per day to a level of 2,500 pounds per day average at the current date.

To indicate the scope and depth of the studies which have been undertaken and completed they will be described in some detail. The following indicate the major elements of the company's research and development program on air pollution control systems during the period from 1969 through 1973.

A. Duct System - An engineering firm was retained to inspect, check and recommend changes to improve gas flow by reducing the pressure drop. THe entire system was checked for flow rate, velocity, pressure drop and grain loading. Isokinetic sampling methods were used to assure the best results from the program. It was concluded that the duct system from the cells to the scrubbers were adequate for the flow-rate and velocities used.

B. Increased Flow Rate and Velocity - A test was initiated to double the volume of gas of 600 C.F.M. collected at each cell. If successful, the volume could further be increased to reduce potline roof emissions. THis test continued for six months. Based on pot operating conditions and the amounts of fluoride collected, it was determined that a cell could not be efficiently operated without large burn-off at any volume greater than 600 C.F.M.

C. Consultants - American Air Filter Corporation, Ducon Corporation, Pulverized Machinery and others were brought to the plant to make recommendations for roof line corrections, improvements in gas collection at the cell and improved treatment at the scrubbers. Suggestions were made for improvements in the scrubber system but no one made any reasonable and workable suggestion for improving collection at the cell or at the roof monitors.

D. Cell Gas Burner for Burning Carbon Monoxide and Tars - A new design was developed and tested on several cells to improve the burner so it would burn continuously and more effectively. Tests indicated little or no improvement could be made to the existing burner.

E. Scrubber Improvement Tests - Tests were made to determine if the standby fan in each scrubber could be used to increase the available pressure drop in order to use a more efficient type of scrubber. Tests were successful. THis provided the opportunity for a scrubber development program with promise to reduce the fluoride and particulate output of each of the scrubbers.

Two pilot units were installed, one from Ducon Corporation and the second from American Air Filter. Both were venturi type units. THey were tested on gases from the cells. Input and output loadings as well as efficiency were studies using various gas to water ratios.

A horizontal venturi of commercial size was tested at one scrubber location. This unit did not achieve the efficiency required and was discontinued.

Preliminary results indicated that a vertical venturi scrubber after the multiclone with a packed (polypropylene saddles) section three to four feet in height in the scrubber tower warranted a full scale test. Such test was successful and a second unit was ordered.

The two units were tested for several months and the results were favorable. Twenty-eight were ordered and installed in April, 1971 at a cost of $577,756. THe efficiency of removal of fluorides improved from 89% to 99%.

F. Improvements in Operating Techniques - During the testing of the pilot units, a careful review of operating practices was initiated. Improvements were made in the seals at the cells as well as to the method of treating open crust area resulting from "sick cells." To assure a continuation of good operating practices, meetings are being held each month with operating personnel to review and correct deficiencies that may arise.

G. Scrubber and Duct Cleaning - Crews are used to clean the duct system which plugs periodically as a result of "pot blows" and changing gas temperature. The number of crews was increased from one crew for the entire plant to a crew for each potline. Improvements in operation of the system were noted almost immediately. The number of employees used to maintain the duct and scrubber system was increased to 15, exclusive of daily skirt changing and other types of maintenance.

H. Wrapping of the Gooseneck Section - With the improved operation of the duct system, as a result of additional maintenance, it was observed that the gooseneck section continued to leak gas under some conditions. In 1970, all the gooseneck sections were wrapped with asbestos cloth, preventing the gas leaks. The cost of this wrapping was $35,600.

I. Reduction of Fluoride Emissions - By the summer of 1970, the Company had achieved a 33-1/3% reduction of fluoride emissions, from 7,500 pounds per day to 5,000 pounds per day. It was then that the venturi scrubbers were installed and the fluoride emitted from the plant was further reduced from 5,000 pounds per day to 2,500 pounds per day, a 66-2/3% reduction from the 1969 level.

J. Visitation to European and U.S. Plants - Anaconda personnel again visited various plants in the U.S. and Canada to determine if there was any device or system including wet scrubbers which was in use or could be modified for application tothe Columbia Falls plant to further reduce emissions through either a primary or secondary system. A team of Anaconda technical personnel recently went to Europe to see what pollution control devices were available. Consultants from other major aluminum producers were contacted and reviewed the problem. Nothing was discovered which would control the roof emissions of the vertical stud Soderberg at Columbia Falls within Montana's prescribed limits.

1972 was the first year to demonstrate the full effect of the previous years' work in improvements of the plant and operations. A full year of testing demonstrated that the 2,500 pounds per day average fluoride output reported to the State Board of Health could be maintained.

The problem of particulate emissions was given attention concurrently with the fluoride problem. The following test work was performed leading to plant modification.

K. Wide Anodes - It was determined that a wider anode would reduce the current density which in turn would reduce the temperature at the top of the anode. The reduction of temperature would reduce the emissions from the anode escaping as particulate from the potroom roofs. This was done to all anodes at a cost of $229,200.

L. Anode Cooling Fins - Aluminum fins were imbedded in the anode paste at the top of the anode in an attempt to cool the paste and thus reduce particulate emissions out of the roofs of the potrooms. The test was made on several cells and it was found that the temperature was not significantly reduced to lower the anode temperature.

M. Anode Pin Tips - It had been the practice to permit the steel pins to be used in the cell until seven inches at the tip were used. As a result of study a change was made to reduce this to five inches. This provides for a cooler anode, better current distribution and lower particulate emissions from the cell.

N. Installation of Potline Computers - A computer program is being installed. To date three potlines have been fully computerized. The other two potlines will be computerized in the near future. The computer program automatically controls and checks voltage levels, and produces a more uniform operation. Specifically, there are fewer "sick pots" and much less open skirt area. Emissions from the plant should be reduced. The cost of this project is estimated at $600,000.

O. Drain Line Pump - Pumps have been installed to pull the scrubber effluent from the scrubber lines to the waste treatment plant. This should prevent scrubber shut down for cleaning drain lines plugging as a result of deposits on the walls of the piping.

P. Use of Petroleum Pitch and Fluid Coke - Tests using petroleum pitch and fluid coke in an attempt to reduce the hydrocarbons and thus prevent the particulate discharge at the top of the anode are being made.

These efforts illustrate Anaconda's diligence and good faith efforts in studying, identifying and correcting its environmental problems on the basis of demonstrated feasibility.

V. PROPOSED ADDITIONAL AIR POLLUTION CONTROL EFFORTS.

At present there seem to be only three additional air pollution control strategies which could reduce the current level of the plant's emissions. The first would be to convert the plant to so-called "pre-bake" anodes. Such a conversion would cost approximately $80 million and would raise production costs to a point which would make the plant uneconomical.

A second possibility is the installation of roof scrubbers. The use of wet roof scrubbers has been investigated in depth and Anaconda continues to study the possibility of their use carefully. To date the use of roof scrubbers has been rejected for several reasons. First, wet scrubbers could not be operated on the roof of the plant during the sub-freezing weather which is experienced for many months of the year at the Columbia Falls plant. Second, since the plant is a Soderberg plant, there are high levels of pitch present in the fumes which are fed through the scrubbers, resulting in deposits on the fans and clogging. These problems result in high maintenance costs. High levels of fluoride in the scrubbing medium also results in corrosion and deterioration of the scrubbing system. Perhaps most discouraging of all the factors is the simple fact that even if roof scrubbers were installed they would not be capable of meeting the Montana standard. Montana's standard is approximately 1.75 pounds of fluoride per ton per day.[1] The better of the two vertical stud Soderberg plants where roof scrubbers have been installed, at The Dalles in Oregon, had fluoride emissions in excess of 2 pounds per day per ton during 1972. The same plant returns the acid-laden effluent to the river, and its roof scrubbers were out of operation for two months during last year due to freezing weather conditions. The Columbia Falls plant experiences sub-freezing weather for much longer periods each year than at The Dalles. THus, it appears that wet roof scrubbers are not a feasible or desirable alternative for the Columbia Falls plant from either an ecological or an economic standpoint.

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[1] Arrived at by applying Montana's 864 pounds per day limitation to the Company's production of approximately 500 tons per day.

There is, however, a third alternative which the company is actively considering, namely, the use of foam scrubbing equipment. Such equipment has been installed only on stacks of various types of industrial plants. It uses a recyclable foam scrubbing medium, and it may be able to meet the Montana standard. A team of Anaconda technical personnel has recently visited a plant using such equipment and is evaluating its application to the Columbia Falls plant. A $50,000 foam scrubbing unit has been ordered and will be delivered in August 1973. The unit will be tested for a period of six months. If economic and operational factors prove satisfactory, a second foam scrubbing unit will be installed on a sixty foot section of the roof line of one potroom by June of 1974 at an estimated capital cost of $95,000. This installation would be tested and evaluated for an entire season of twelve months, and again, assuming satisfactory economic and operational factors would be installed on the entire roof of a pot room, at an estimated capital cost of $1,450,000. Thereafter, depending on satisfactory performance, additional installations would be made toward meeting Montana standards.

Anaconda Aluminum intends to continue not only to apply the best available technology to its Columbia Falls plant, but to diligently strive to develop new technology which can be practically applied to the Columbia Falls plant. It is with that purpose and for that reason that Anaconda Aluminum applies for a one year variance, subject to renewal for such additional time period as may be required for achievement of a practical solution to meet Montana's strict air pollution control standards.

VI. NO HARM TO PUBLIC HEALTH OR SAFETY WILL RESULT FROM GRANTING THE VARIANCE.

There are no effects on human health or safety which result from the plant's emissions of fluorides and particulates. Ambient air samples are the highest levels of concentration sampled within the vicity of the plant range between 0.1 parts per billion to 3.5 parts per billion at a maximum. These levels are far below those at which any effect on human health or safety would be experienced. Not a single case of fluorosis in humans has been encountered in the plant's history, nor has any other adverse effect on human health or safety been shown to exist.

VII. ADVANTAGES AND DISADVANTAGES RESULTING FROM GRANTING OR DENYING THE VARIANCE.

In order to grant the variance requested by Anaconda Aluminum, the Board must find that the emissions occurring or proposed to occur do not constitute a danger to public health or safety and that compliance with the Montana standard would produce hardship without equal or greater benefits to the public. Anaconda Aluminum submits and intends to prove that this is indeed the case. Anaconda Aluminum believes that the granting of the variance is fully consistent with and will aid in implementing the policy and purpose of the Clean Air Act of Montana:

> "...to achieve and maintain such levels of air quality as will protect human health, safety, and to the greatest degree practicable, prevent injury to plant and animal life and property, foster the comfort and convenience of the people, promote the economic and social development of this state and facilitate the enjoyment of the natural attractions of this state." Section 69-3905, Revised Codes of Montana.

Compliance today with Montana's air pollution control regulations is only possible by closing the plant. The alternative is to grant a variance to enable the plant to continue to operate. The hardship to the public, the Anaconda Company and its employees and the benefits, if any, resulting from requiring compliance will be discussed in terms of the disadvantages of requiring compliance with the Montana Regulation for aluminum reduction plants.

A. Disadvantages resulting from requiring compliance.

As stated above, the only manner of obtaining compliance with the Montana standard by

June 30, 1973 is the closing of the plant. THe plant currently provides employment for 911 residents of the Flathead Valley earning a total of approximately $9.5 million per year. Since opportunities for employment are very limited in the Flathead Valley and there is already substantial unemployment in the Valley, the closing of the plant would result in unemployment for most of these employees.

Through the multiplier effect the plant's $9.5 million income to the Valley is spent approximately seven to ten times. This income contributes substantially and indispensably to the economic well-being of the entire Valley. THis income is used for the purchase of a substantial portion of virtually all of the goods and services produced in the Flathead Valley and its absence would certainly cause a depression in the economy of the Flathead Valley.

Anaconda Aluminum pays ad valorem taxes on the Columbia Falls plant in an annual amount of $1,380,000.00. THis constitutes 14.3% of the tax revenue of Flathead County, Montana. Loss of this revenue would mean cuts in school budgets, highway and road construction and maintenance, social services, and all public activities of the county. At the same time, the burden on public revenues would be increased by the welfare and unemployment compensation payments resulting from closing the plant. In addition to public revenues paid to Flathead County, Anaconda Aluminum and its employees pay very substantial income taxes both to the State of Montana and the United States. Again, a cut in these revenues could cause a loss of public services.

In addition to the direct effect on the Flathead Valley, an additional 1,754 employees of Anaconda throughout the Unites States are engaged in fabrication of the aluminum produced by the Columbia Falls plant and would lose their jobs with its closing. THese employees earn a total of $20 million per year. Anaconda also has a depreciated capital investment in the fabricating facilities dependent upon the plant of $32 million. Altogether, a closing of the Columbia Falls plant would result in the direct loss of approximately $30 million in income, approximately $100 million in plant investment and several million dollars in public revenues.

The losses, of course, would not end with these direct losses. THere would be significant losses to the numerous suppliers of the plant, including railroads, grocers, merchants, and numerous other enterprises which serve the populace of the Flathead Valley. Customers who purchase the plant's aluminum production would also be adversely affected. Aluminum is a vital metal in the nation's economy which fortunately lends itself to recycling, an increasingly important ecological factor in the use of metals.

B. Advantages of requiring compliance.

There would be little advantage to the Flathead Valley or the State of Montana from requiring a closing of the plant. Benefit in terms of reduction of air contaminants would be mainly aesthetic and confined to the local vicinity of the plant itself. As indicated above, there is no damage to human health or safety; nor is there any danger from eating plants or vegetables grown in the Columbia Falls area.

There is a limited effect upon the most sensitive forms of vegetation in the immediate vicinity of the plant. According to several experts on vegetation, the paving of dusty streets in Columbia Falls would do far more to improve the health of the vegetation of the Columbia Falls area than the closing of the plant. The amount of damage done to vegetation, which is speculative, would in any case be a tiny fraction of the economic impact which the closing of the plant would cause.

On the basis of the information supplied herein, Anaconda Aluminum requests an exemption from compliance with the applicable Board regulations for one year for its Columbia Falls plant. The granting of this exemption will enable the company to continue to operate at its Columbia Falls plant with the maximum available technically and economically feasible air pollution control equipment.

Anaconda Aluminum will be pleased to supply the Board with any additional information that it may desire with respect to this Petition.

Respectfully submitted,

ANACONDA ALUMINUM COMPANY
DIVISION OF THE ANACONDA COMPANY

Original signed by E. O. Woster

Dated: June 30, 1973

16-2.14(1)-S1430 PARTICULATE MATTERS, INDUSTRIAL PROCESSES (1) No person shall cause, suffer, allow, or permit to be discharged into the outdoor atmosphere from any operation, process or activity, except fuel burning equipment and incinerators, particulate matter in excess of the amount shown in the following table. When the process weight falls between two values in the table, the maximum weight discharged per hour shall be determined by interpolatin.

When the process weight exceeds 60,000 pounds per hour, the maximum allowable weight discharged per hour will be determined by use of the following equation:

$$E = 55.0\ P^{0.11-40}$$

Where E = Maximum rate of emission in pounds per hour, P = Process weight rate in tons per hour.

Process Weight Rate lb/hr	Tons/hr	Rate of Emission lb/hr
100	0.05	0.551
200	0.10	0.877
400	0.20	1.40
600	0.30	1.83
800	0.40	2.22
1,000	0.50	2.58
1,500	0.75	3.38
2,000	1.00	4.10
2,500	1.25	4.76
3,000	1.50	5.38
3,500	1.75	5.96
4,000	2.00	6.52
5,000	2.50	7.58
6,000	3.00	8.56
7,000	3.50	9.49
8,000	4.00	10.4
9,000	4.50	11.2
10,000	5.00	12.0
12,000	6.00	13.6
16,000	8.00	16.5
18,000	9.00	17.9
20,000	10.00	19.2
30,000	15.00	25.2
40,000	20.00	30.5
50,000	25.00	35.4
60,000	30.00	40.0
70,000	35.00	41.3
80,000	40.00	42.5
90,000	45.00	43.6
100,000	50.00	44.6
120,000	60.00	46.3
140,000	70.00	47.8
160,000	80.00	49.0
200,000	100.00	51.2
1,000,000	500.00	69.0
2,000,000	1,000.00	77.6
6,000,000	3,000.00	92.7

Interpolation of the data in this table for process weight rates up to 60,000 lb/hr shall be accomplished by use of the equation:

$E = 4.10 P^{0.67}$.

Interpolation and extrapolation of the data for process weight rates in excess of 60,000 lb/hr shall be accomplished by use of the equation:

$E = 55.0 P^{0.11} - 40$.

Where E = rate of emission in lb/hr and P = process weight rate in tons/hr.

16-2.14(1)-S1460 VISIBLE AIR CONTAMINANTS, RESTRICTIONS

(1) Restriction of Existing Installations

No person shall cause, suffer, allow or permit emissions from any installations which are:

(a) Of a shade or density darker than that designated as No. 2 on the Ringelmann Chart, or

(b) Of such opacity as to obscure an observer's view to a degree greater than does smoke described in subsection (1)(a) of this regulation.

This section does not apply to existing incinerators or existing wood waste burners.

(2) Restriction of New Installations and All Incinerators

No person shall discharge into the atmosphere from any single source of emission whatsoever any air contaminant:

(a) Shade or density darker than that designated as No. 1 on the Ringelmann Chart, or

(b) Of such opacity as to obscure an observer's view to a degree greater than does smoke described in subsection (2)(a) of this regulation.

(3) The provisions of sections (1) and (2) of this rule shall not apply to emissions during the building of a new fire, cleaning of fires or soot blowing, the shade or density of which is less than No. 3 on the Ringelmann Smoke Chart or of such opacity as to obscure an observer's view to a degree greater than does smoke designated as No. 3 on the Ringelmann Smoke Chart for a period or periods aggregating no more than four minutes in any 60 minutes.

Where the presence of uncombined water is the only reason for failure of an emission to meet the requirements of sections (1) and (2) of this regulation, such sections shall not apply.

The provisions of section (1) of this regulation shall not apply to the following:

(a) Transfer of molten metals.

(b) Emissions from transfer ladles.

16-2.14(1)-S14080 ALUMINUM PLANTS, FLUORIDE EMISSIONS

(1) No person or persons shall cause, suffer, allow or permit to be discharged into the outdoor atmosphere from any primary aluminum reduction plant, aluminum smelter or aluminum manufacturing plant either in a gaseous or particulate form or any combination of gaseous or particulate forms fluorides in excess of 0.060 pounds per hour per reduction cell commonly called a "pot". For operations producing aluminum at an annual rate of more than 200,000 tons, the combined emission of fluorides into the outdoor atmosphere from all pots regardless of the number shall not exceed 40.0 pounds per hour. The total of all particulate matter including particulate fluoride emitted from all of the pot rooms combined shall not exceed that allowed under MAC 16-2.14(1)-S14030 or MAC 16-2.14(1)-S1460 formulated under the Clean Air Act of Montana.

(2) Definitions:

"Reduction cell" or "pot" means a shallow carbon-lined steel vessel (cathode) containing molten cryolite and aluminum into which is suspended a carbon anode.

"Pot room" means a large building or room which houses up to several hundred pots or reduction cells.

"Plant" means primary aluminum reduction plant, aluminum smelter or aluminum manufacturing plant.

(3) Unless the gaseous portion of the fluorides emitted at any fluorides emission point is more than 50 percent of the total fluorides emitted, the results of sampling may be reported on a total fluoride basis. Sampling under such circumstances may be done without differentiation between gaseous and particulate phases of the emissions but all emitted fluorides must be collected as completely as possible.

Each existing plant to which this rule applies shall submit to the director, at least 90 days before the effective date of this rule, a detailed monitoring program including, but not limited to, the following:

(a) A description of monitoring equipment and procedures capable of determining compliance with this regulation.

(b) A description of the sources to be monitored which shall include the stack of any fluoride scrubber or any fluoride or particulate emission control device or emission point at the pots or pot rooms.

(i) Unless otherwise authorized by the director, data for each calendar month shall be reported by each plant not later than 15 days after the end of each calendar month.

(ii) The data submitted must include the average daily emission of fluorides, as total fluorides, expressed in pounds per hour per operated pot. A pot must operate 75 percent of the time during the reporting period to qualify as an operating pot.

(iii) The number of pots operating during the reporting period must be reported.

(c) Within 30 days after approval of the detailed monitoring program by the director, the approved equipment shall be ordered by the plant. Within 30 days after receipt of the approved equipment from the vendor, the equipment shall be installed and operating. Reporting of the results shall begin as provided for in section (2) at the end of the calendar month in which the monitoring equipment is installed and each month thereafter as indicated.

Each plant shall furnish, upon request of the director, such other pertinent data as may be required to evaluate the plant's emission control program.

(4) The effective date of this rule shall be June 30, 1970 for new plants and June 30, 1973, for existing plants.

APPENDIX B
AMBIENT SAMPLING & SITE ID--EPA & SDHES

LOCATION AND ELEVATION OF FLUORIDATION NETWORK SITES

Site number	Elevation above mean sea level, feet	Location
1	3150	Glacier Park; near Fire Weather Station
2	3100	Blankenship Ranch
3	3200	Rose Ranch
4	3250	Near railroad and Blankenship Road crossing
5	3040	DeMerritt Property
6	3000	Northeast of Whitefish
7	3145	Upper Lake McDonald; at Ranger Station
8	3145	Lower Lake McDonald; near Apgar
9	3800	Camas Creek Road; on trail to Huckeberry Mountain
10	3350	North Fork Road; near Big Creek Ranger Station
11	3500	North Fork Road; 5 miles north of station 3
12	2993	Northwest end of Lake Blaine
13	2900	South of Creston; along Highway 35
14	3250	Highway 2; 2 miles south of Park headquarters
15	3400	East side of Teakettle Mountain
16	3320	North Ford Road; near Turnbull Creek turnoff
17	3100	Dehlbom property
18	3050	Badrock Canyon
19	5200	Apgar Lookout
20	3150	Park headquarters
21	3580	Vicinity of Hungry Horse Dam
22	4200	Emery Hill
23	3150	Coram
24	3400	Boehm's Bear Den
25	3280	Base of Apgar ridge
26	3400	Red Eagle; near Nyack
27	3260	Kootenai Creek; east of West Glacier
28	3145	Southeast side of Lake McDonald
30	3400	Hill above Park headquarters
32	3070	North of Morning Slough Lake
33	3050	South of Morning Slough Lake
33	3050	Southeast of Morning Slough Lake
34	3920	Teakettle Mountain; 3 miles north of Relay Tower
35	4200	Teakettle Mountain, 1.5 miles north of Relay Tower
36	3400	Hill near gravel pit, on Highway 2
37	3250	Hill above Park headquarters; 150 feet feet below site 30

MONTHLY FLUORIDATION RATE MEASUREMENT RESULTS

Site Number	Fluoridation rate, μg F/cm^2-day					
	July	August	September	October	November	Average Monthly Rate
1[a]	11[b]	13[b]	9[b]	10[b]	10[b]	11
2[a]	14[b]	13[b]	20[b]	11[b]	13[b]	14
3[a]	10[b]	10[b]	10[b]	4[b]	6[b]	8
4[a]	15[b]	23[b]	11[b]	12[b]	13[b]	15
5	29	30	32	16	--	27
6	15	10[b]	7[b]	4[b]	--	9
7[a]	14	9	8	7	--	10
8[a]	15	8	7	6	8	9
9[a]	10	5	4	4	--	6
10	9	5	4	2	--	5
11	9	8	3	2	--	6
12	7	--	3	2	--	4
13	10	--	4	4	--	6
14	13	12	9	5	6	9
15	17	19	14[b]	9[b]	10[b]	14
16	12	12	6[b]	5[b]	--	9
17	38	83[b]	43[b]	43[b]	23[b]	46
18	23	30[b]	21[b]	25[b]	37[b]	27
19[a]	20	29	48	22	--	30
20[a]	13	16	8	5	5	9
21	10	4[b]	5[b]	4[b]	--	6
22	8	5[b]	5[b]	3[b]	--	5
23	13	18[b]	13[b]	8[b]	16[b]	14
24[a]	9	8	5	3	--	6
25[a]	24	24[b]	26[b]	11[b]	18[b]	21
26	10	7[b]	6[b]	4[b]	--	7
27	6	7[b]	6[b]	4[b]	8[b]	6
28[a]	10	6	5	3	--	6
30[a]	--	--	--	8	8[b]	8
32	--	15[b]	9[b]	10	--	12
33	--	6[b]	5[b]	4[b]	--	5
33M	--	6[b]	5[b]	4[b]	--	5
34	--	37	41	--	--	39
35	--	--	50[b]	91[b]	--	71
36	--	--	--	--	9	9
37[a]	--	--	--	--	9	9

a Exposure sites located in or near Glacier Park

b Value is average of two or more duplicate readings

Std. 0 3 - 28 days
0.321 - 30 days

SDHES
AMBIENT FLUORIDE
ug/cm^2/30 days

Key: average / maximum   # of violaions / # of months data

Station	1973		1972		1971		1970		1969	
986 9th Avenue	0.265	3	0.242	2	0.539	6				
0270001	0.470	10	0.700	12	1.200	8				
High School							0.673	5	2.413	7
0270002							1.200	6	5.150	7
Jr. High School							0.960	8	2.827	9
0270 003							1.410	8	6.110	9
Dehlboms	0.471	6	0.881	12	1.097	10	1.048	9	4.335	8
0480 002	0.870	9	1.640	12	2.100	11	1.500	9	9.080	8
Feirstein										
0003	0.373	6	0.542	8	0.771	10	0.699	8	1.617	7
	0.620	10	1.130	12	1.500	11	1.200	9	3.100	8
Re Owen	0.181	1	0.215	2	0.267	2				
004	0.500	9	0.380	12	0.430	9				
Badrock Subs.	0.169	0	0.412	9	0.460	9	1.163	7	1.244	8
005	0.250	10	0.610	12	0.730	11	4.800	9	3.780	8
Cedar Rdg. Rd.	0.077	0	0.115	1	0.063	0				
006	0.160	7	1.000	11	0.130	9				
Opalka							0.172	0	0.866	5
0480007							0.230	8	2.280	8
Dehlbom N							1.260	8	4.747	8
0480008							1.900	8	9.730	8
Sedivy							1.000	8	2.377	7
0480009							1.700	8	4.700	8
Dehlboms Field	0.489	6	1.064	8						
012	0.980	9	2.700	8						
Anaconda So.	3.081	9	8.570	7						
013	5.560	9	10.200	7						

Station	1973	1972	1971	1970	1969
F. Co. H.S. 0800007				$\frac{0.081}{0.190}$ $\frac{0}{6}$	$\frac{0.197}{0.430}$ $\frac{1}{8}$
W. Evergreen 0800008				$\frac{0.068}{0.100}$ $\frac{0}{8}$	$\frac{0.271}{0.710}$ $\frac{2}{8}$
Teakettle #1 014	$\frac{4.007}{4.840}$ $\frac{10}{10}$	$\frac{5.587}{10.280}$ $\frac{8}{8}$			
Teakettle #2 015	$\frac{5.408}{10.850}$ $\frac{6}{6}$	$\frac{7.451}{12.070}$ $\frac{7}{7}$			
Teakettle #3 016	$\frac{2.100}{2.600}$ $\frac{9}{9}$	$\frac{2.781}{5.500}$ $\frac{7}{7}$			
Teakettle #4 017	$\frac{3.024}{3.670}$ $\frac{5}{5}$	$\frac{2.017}{4.660}$ $\frac{2}{3}$			
Teakettle #5 018	$\frac{1.086}{2.170}$ $\frac{8}{8}$	$\frac{0.741}{2.000}$ $\frac{5}{6}$			
Teakettle #6 019	$\frac{2.861}{3.880}$ $\frac{10}{10}$	$\frac{5.357}{15.730}$ $\frac{4}{4}$			
Hamilton #1 020	$\frac{0.464}{0.800}$ $\frac{6}{10}$	$\frac{0.417}{0.430}$ $\frac{3}{3}$			
TK #7 021	$\frac{0.270}{0.340}$ $\frac{1}{4}$				
TK #8 022	$\frac{0.226}{0.310}$ $\frac{0}{5}$				
TK #9 023	$\frac{4.930}{8.200}$ $\frac{2}{2}$				
TK #10 024	$\frac{4.596}{7.320}$ $\frac{5}{5}$				
TK #11 025	$\frac{3.814}{13.950}$ $\frac{5}{5}$				
TK #12 026	$\frac{6.340}{6.620}$ $\frac{3}{3}$				

Station	1973	1972	1971	1970	1969
Alum City 023	$\frac{0.499}{1.060}$ $\frac{5}{8}$				
Trailer 029	$\frac{0.370}{0.370}$ $\frac{1}{1}$				
Glacier Park #1 0570003	$\frac{0.073}{0.080}$ $\frac{0}{3}$				
Glacier Park #2 0570004	$\frac{0.140}{0.160}$ $\frac{0}{3}$				

POLYNUCLEAR HYDROCARBON ANALYSIS
OF
AIR IN FLATHEAD VALLEY

		UG/G BS*	UG/G PART**	UG/1000CU M***
CRESTON Fluoranthene	- FLT	298.6	21.5	2.1
Pyrene	- PYR	286.9	20.7	2.0
Benz(a)anthracene	- BAA	75.9	5.5	0.5
Chrysene	- CHY	356.5	25.7	2.5
Benzo(e)pyrene	- BEP	219.1	15.8	1.5
Benzo(a)pyrene	- BAP	167.3	12.1	1.2
Perylene	- PER	17.3	1.3	0.1
Benzo(g,h,i)perylene	- GEE	115.6	8.3	0.8
Anthanthrene	- ANT	7.6	0.5	0.1
Coronene	- COR	37.2	2.7	0.3
KALISPELL	FLT	356.0	41.6	4.5
	PYR	366.9	42.8	4.7
	BAA	96.8	11.3	1.2
	CHY	394.1	46.0	5.0
	BEP	270.1	31.5	3.4
	BAP	234.7	27.4	3.0
	PER	25.6	3.0	0.3
	GEE	187.5	21.9	2.4
	ANT	8.4	1.0	0.1
	COR	82.3	9.6	1.0
COLUMBIA FALLS	FLT	258.3	12.6	2.7
	PYR	250.0	12.2	2.6
	BAA	251.3	12.3	2.7
	CHY	844.8	41.2	8.9
	BEP	782.9	38.2	8.3
	BAP	783.0	38.2	8.3
	PER	70.3	3.4	0.7
	GEE	429.8	21.0	4.5
	ANT	24.5	1.2	0.3
	COR	91.7	4.5	1.0

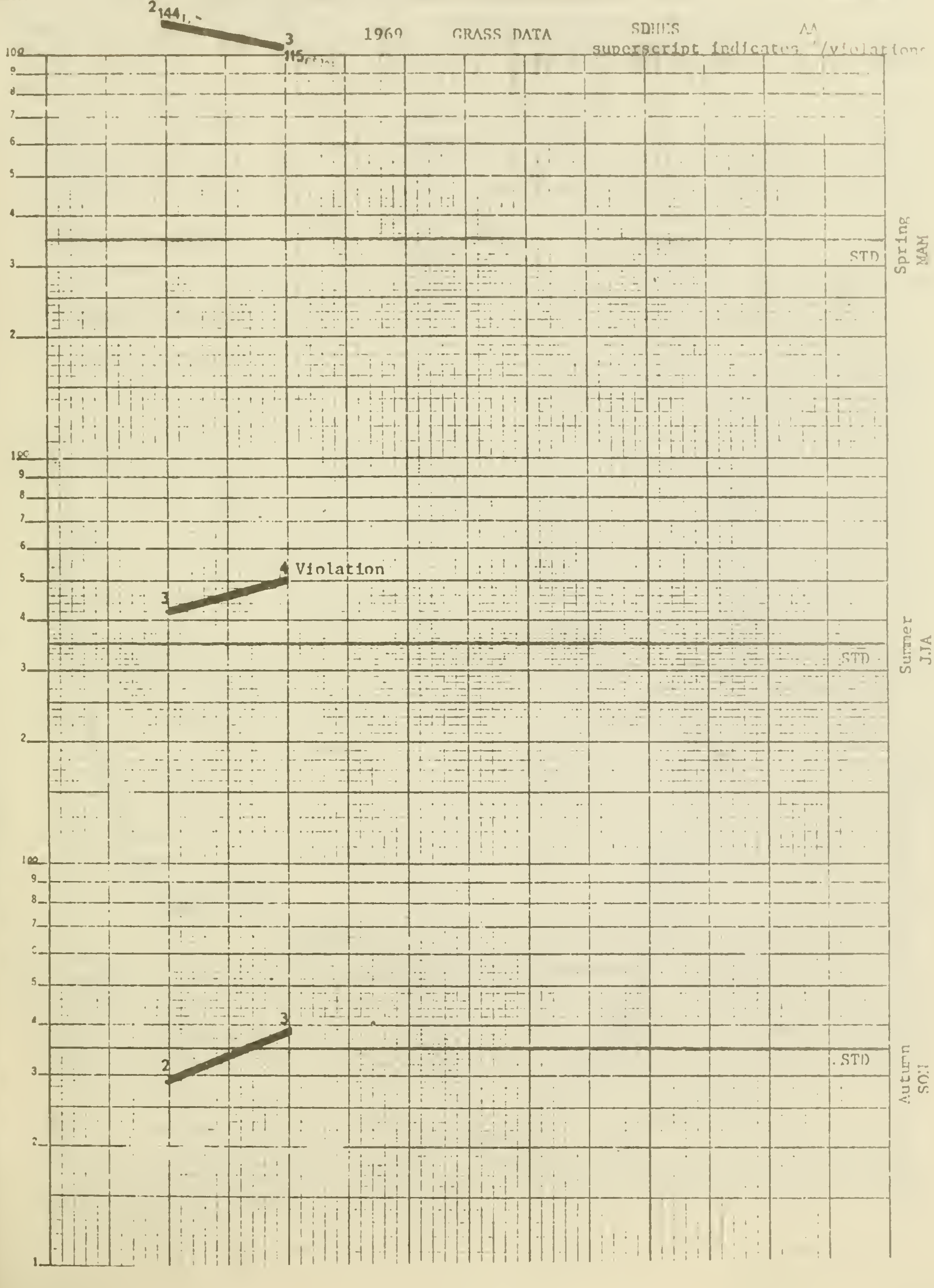
*Micrograms of hydrocarbon per gram of Benzene Soluble Tar.
**Micrograms of hydrocarbon per gram of Total Particulate.
***Micrograms of hydrocarbon per 1000 cubic meters of air.

State Dept of Health (20)

APPENDIX C
FLUORIDE IN VEGETATION--SDHES DATA

1969 GRASS DATA SDHES AA

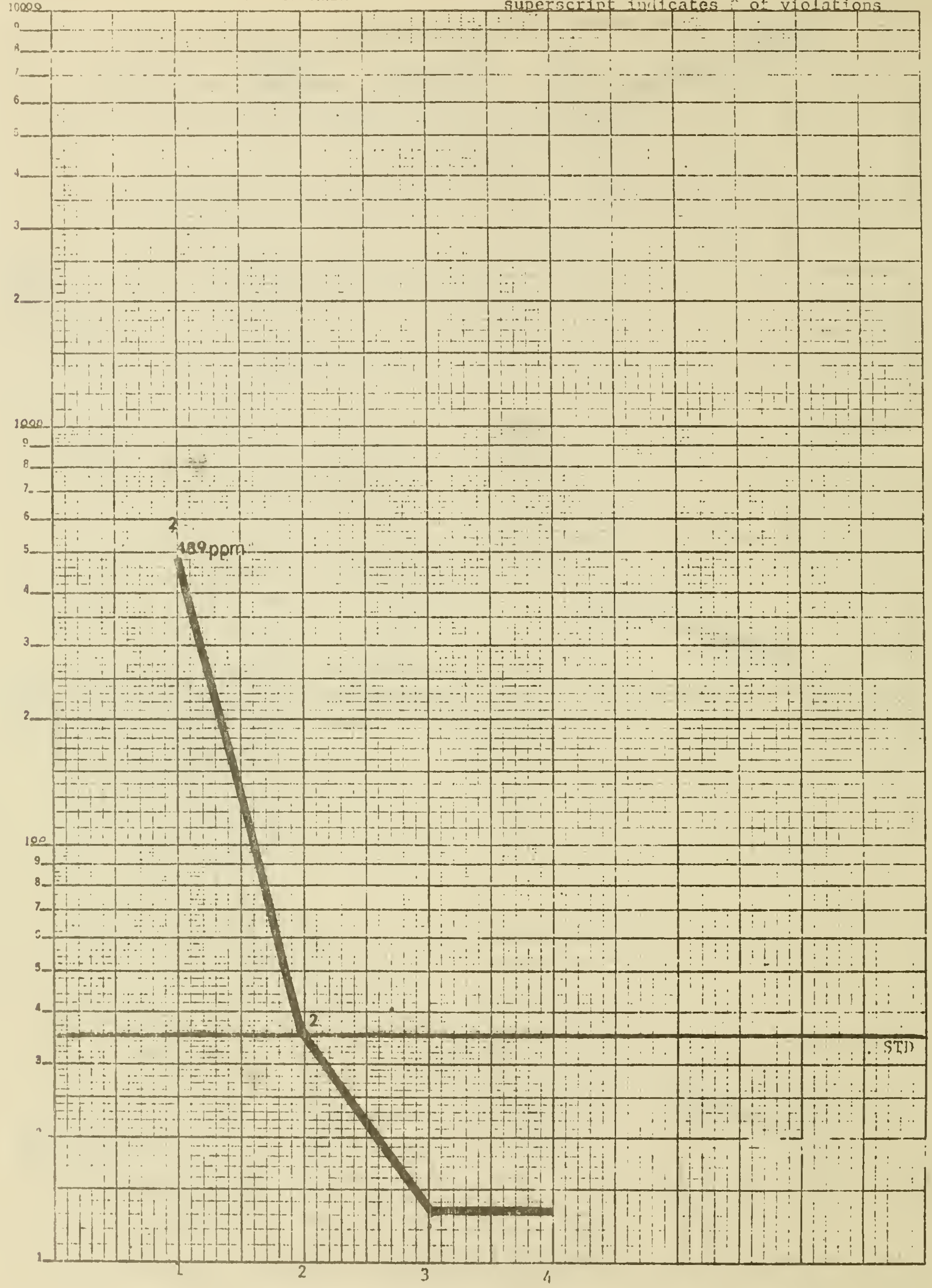
superscript indicates #/violations



[illegible] GRASS SAMPLES SDHES AA

PPM F PPM FLUORIDE

superscript indicates # of violations



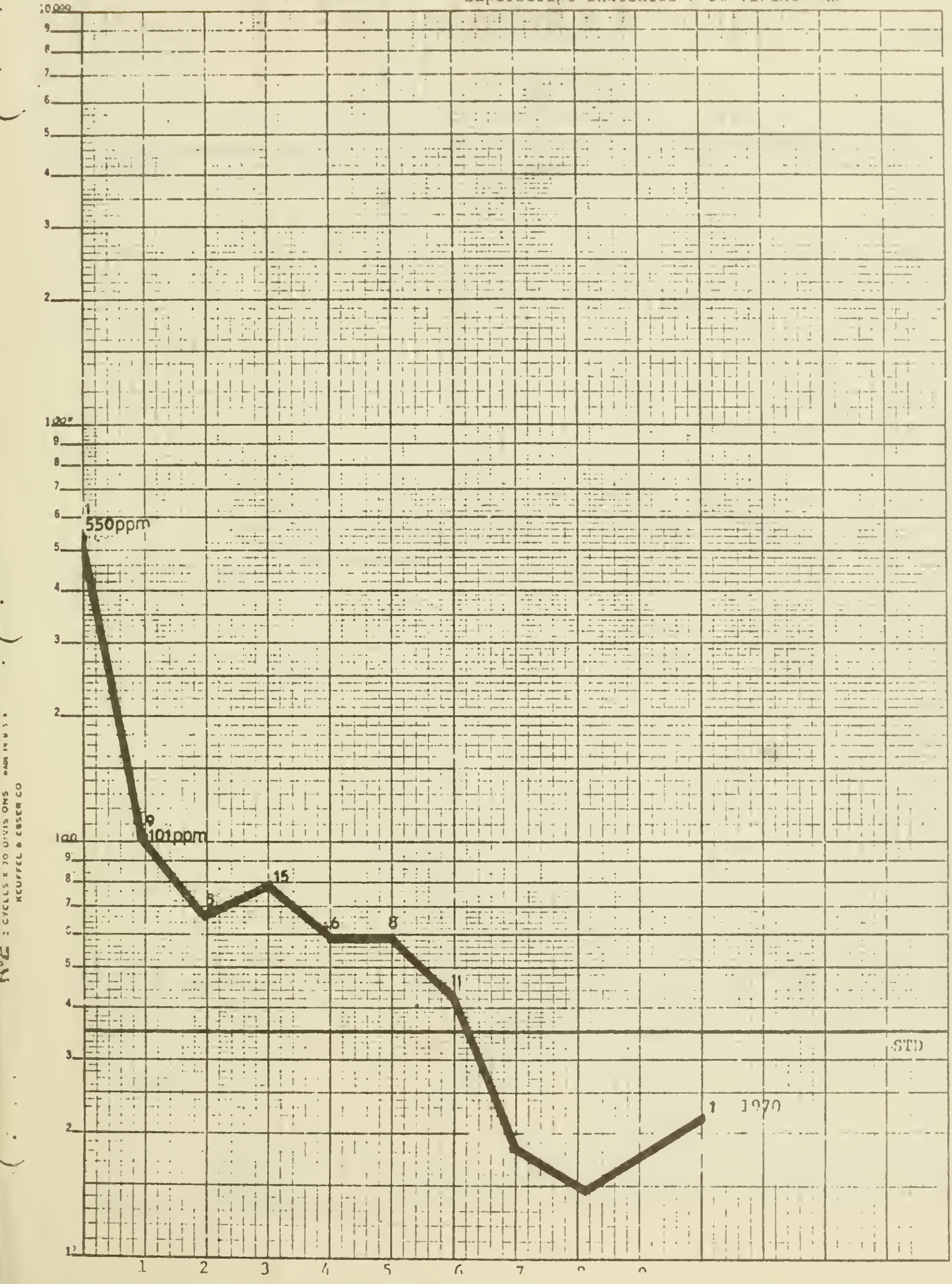
Spring 1973
nar

KEUFFEL & ESSER CO.

CONIFER SAMPLES
PPM FLUORIDE

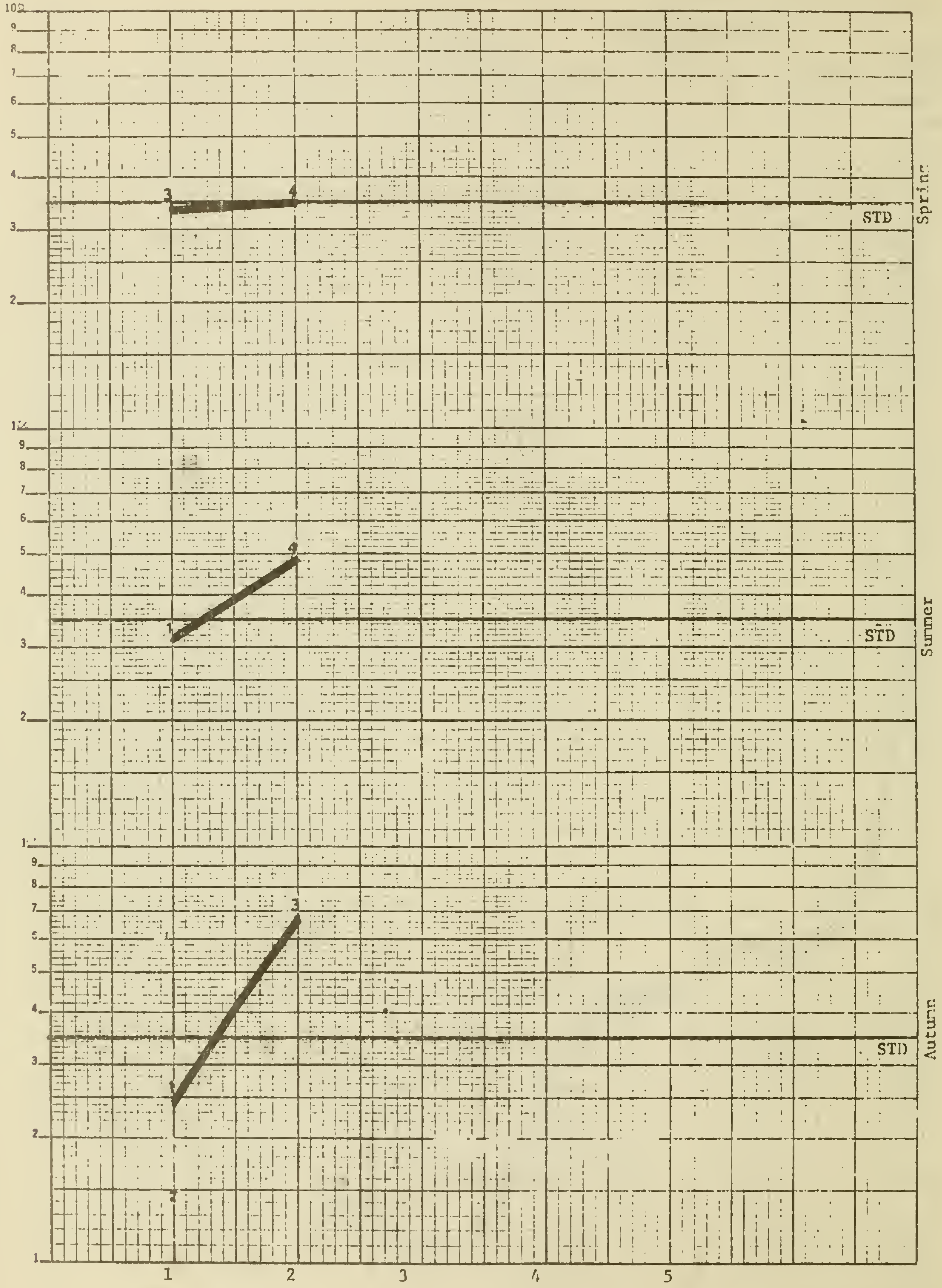
SITES
superscript indicates # of violations

AA



Summer

1970 GRASS DATA SDHES



APPENDIX D
FLUORIDE IN VEGETATION--AAC DATA

ppm Fluoride in Grass Samples
Collected at Various Sites

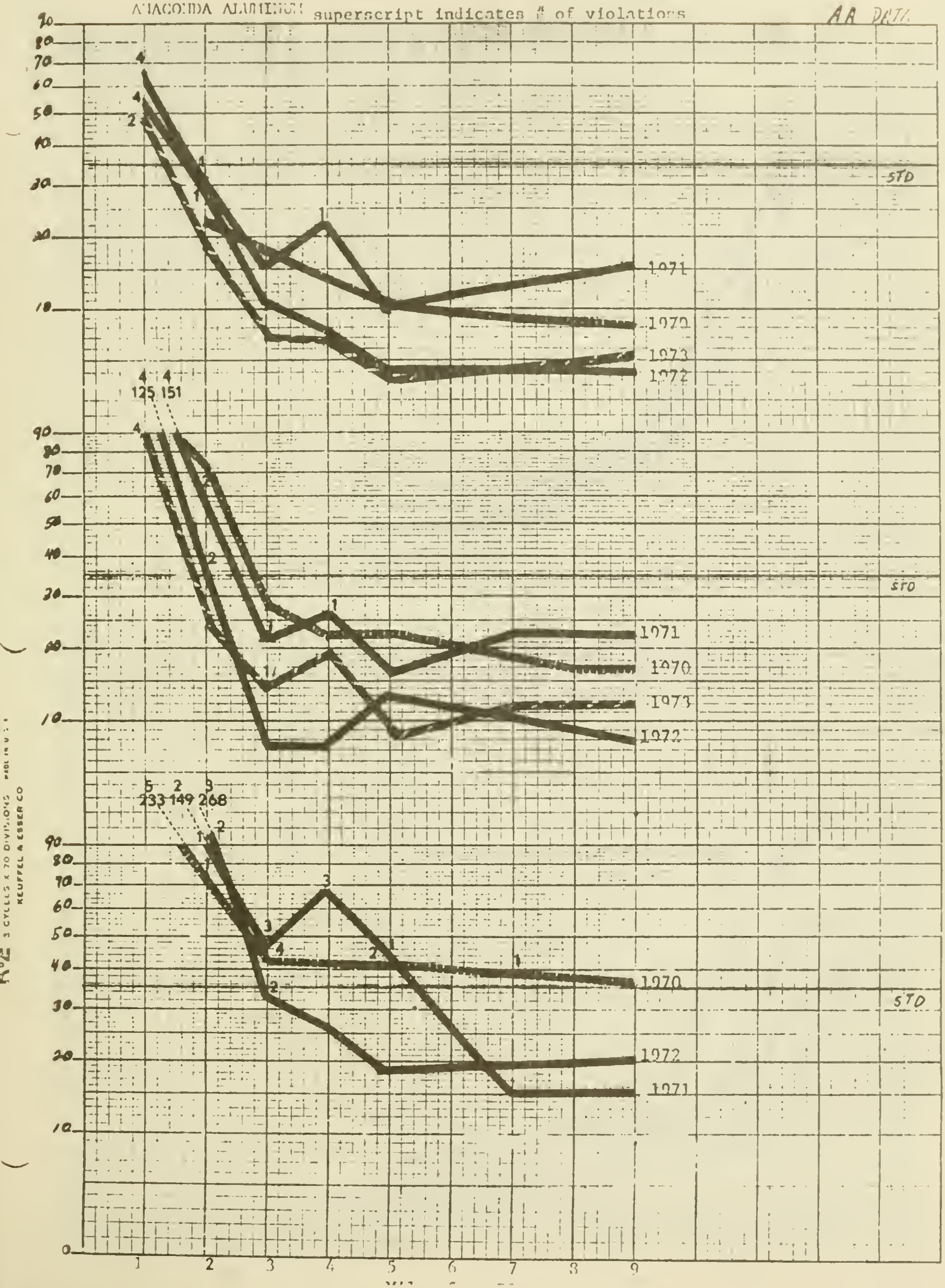
			1970			1971			1972			1973	
Distance	Site #	Spr	Sum	Aut	Spr	Sum	Aut	Spr	Sum	Aut	Spr	Sum	Aut
1 mile	2		21	40.5	14	24	24	14	6	20	6	8	
	6		117	259	57	155	163	69	81	60	21	80	
	7		206	356	55	178	262	42	236	755	112	88	
	19		104	98.5	57	180	-	46	105	-	29	114	
	155		165	413.5	161	220	-	96	198	238	71	129	
	$\bar{x}$		122.6	233.5	68.8	151.4	149.6	53.4	125.2	268.25	47.8	83.8	
2 mile	51	22	8.5	12	22	5	14	10	6	14	4	10	
	152	-	189.5	-	51	118	170	51	49	241	29	-	
	156	-	17.5	138.5	22	57	-	-	52	64	23	38	
	$\bar{x}$	22	71.83	75.25	31.67	60.0	92.0	30.5	35.67	106.33	18.67	24.0	
3 mile	127	9	39.5	485	18	30	41	1	7	43	9	18	
	128	16	18	35	24	22	33	6	2	20	4	6	
	161	-	42.5	63	13	35	70	27	5	-	8	35	
	162	-	27	61	9	18	109	12	13	33	7	13	
	163	-	11.5	17	8	13	15	5	5	8	5	5	
	168	-	-	29	21	20	21	11	14	58	7	10	
	$\bar{x}$	12.5	27.7	41.0	15.5	23.0	48.17	10.33	7.67	32.4	6.67	14.5	
4 mile	120	10	28	34	9	24	40	8	6	20	5	25	
	136	31	19	-	45	37	98	7	14	34	8	72	
	157	-	21.5	24	14	19	63	8	3	27	7	18	
	$\bar{x}$	20.5	22.83	29.0	22.67	26.67	67.0	7.67	7.67	27.0	6.67	18.33	
5 mile	40	17	27.5	76	10	28	62	7	30	31	2	16	
	119	3	7.5	7	5	9	-	2	3	7	6	10	
	148	-	39	38	14	11	26	2	7	17	2	3	
	$\bar{x}$	10.0	24.67	40.33	9.67	16.0	44	3.67	13.33	18.33	3.33	9.67	
7 mile	42	9	24.5	45	19	22	17	6	13	29	6	15	
9 mile	135	7	14	33.5	8	22	13	3	2	9	4	9	

ppm Fluoride in Pine Samples
Collected at Various Sites

		1970			1971			1972			1973		
Distance	Site #	Spr	Sum	Aut	Spr	Sum	Aut	Spr	Sum	Aut	Spr	Sum	Aut
1 mile	2		10.5	13		3	5		3	5		3	
	6		16	23		32	34		6	20		23	
	7		46	60		34	65		38	56		13	
	19		30.5	40.5		10	44		17	44		16	
	155		107.5	131		42	88		29	77		31	
	x̄		42.1	53.5		24.2	47.2		18.6	40.4		17.2	
2 mile	51		4	5		2	6		0	5		2	
	152		72	90		25	61		11	29		13	
	156		24.5	61.5		42	77		31	31		8	
	x̄		33.5	52.16		23.0	48.0		14.0	21.66		7.66	
3 mile	127		23	25		7	8		2	19		3	
	128		32	14		9	13		2	18		3	
	161		23.5	53		15	66		13	25		8	
	162		27.5	38		8	17		-	-		7	
	163		6	8.5		5	4		1	8		3	
	168		7	-		3	4		-	8		3	
	x̄		19.83	28.37		8.0	18.66		4.5	15.6		4.5	
4 mile	120		6	8		3	4		4	4		1	
	136		8	24		12	27		8	17		6	
	157		10.5	9		3	13		13	10		5	
	x̄		8.17	13.67		6.0	14.67		8.33	10.33		4.0	
5 mile	40	37	10	9		8	9		5	7		3	
	119	-	7	8		4	8		4	8		2	
	148	-	4	10.5		5	7		1	14		5	
	x̄		7.0	9.17		5.67	8.0		3.33	9.67		3.33	
7 mile	42		4	6		4	4		0	3		1	
9 mile	135		4	8.5		9	7		2	4		3	

LEVELS OF F (PPM) IN GRASS WITH INCREASING DISTANCE FROM ANACONDA ALUMINUM superscript indicates # of violations

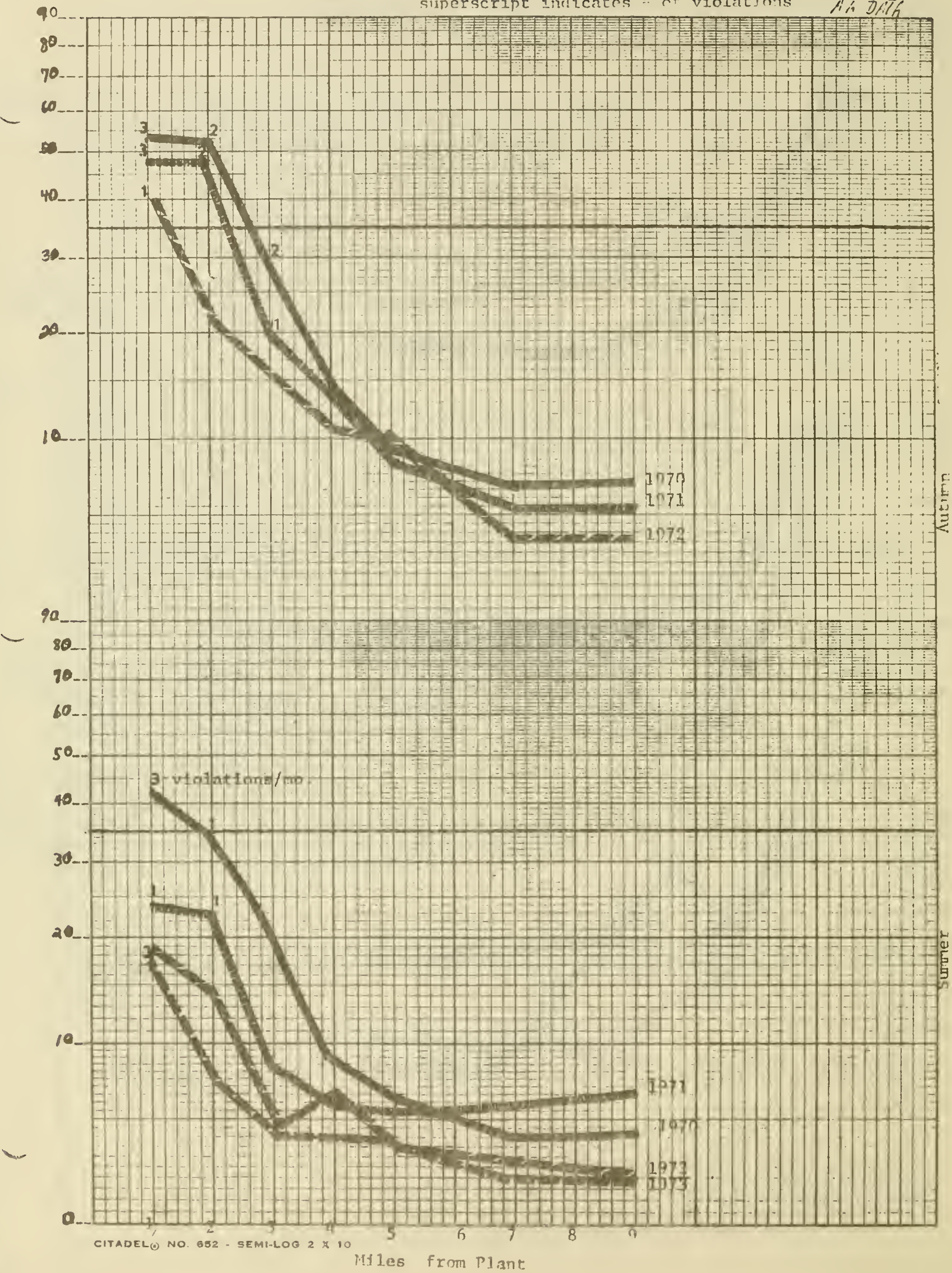
AA DATA



DISTANCE FROM ANACONDA ALUMINUM

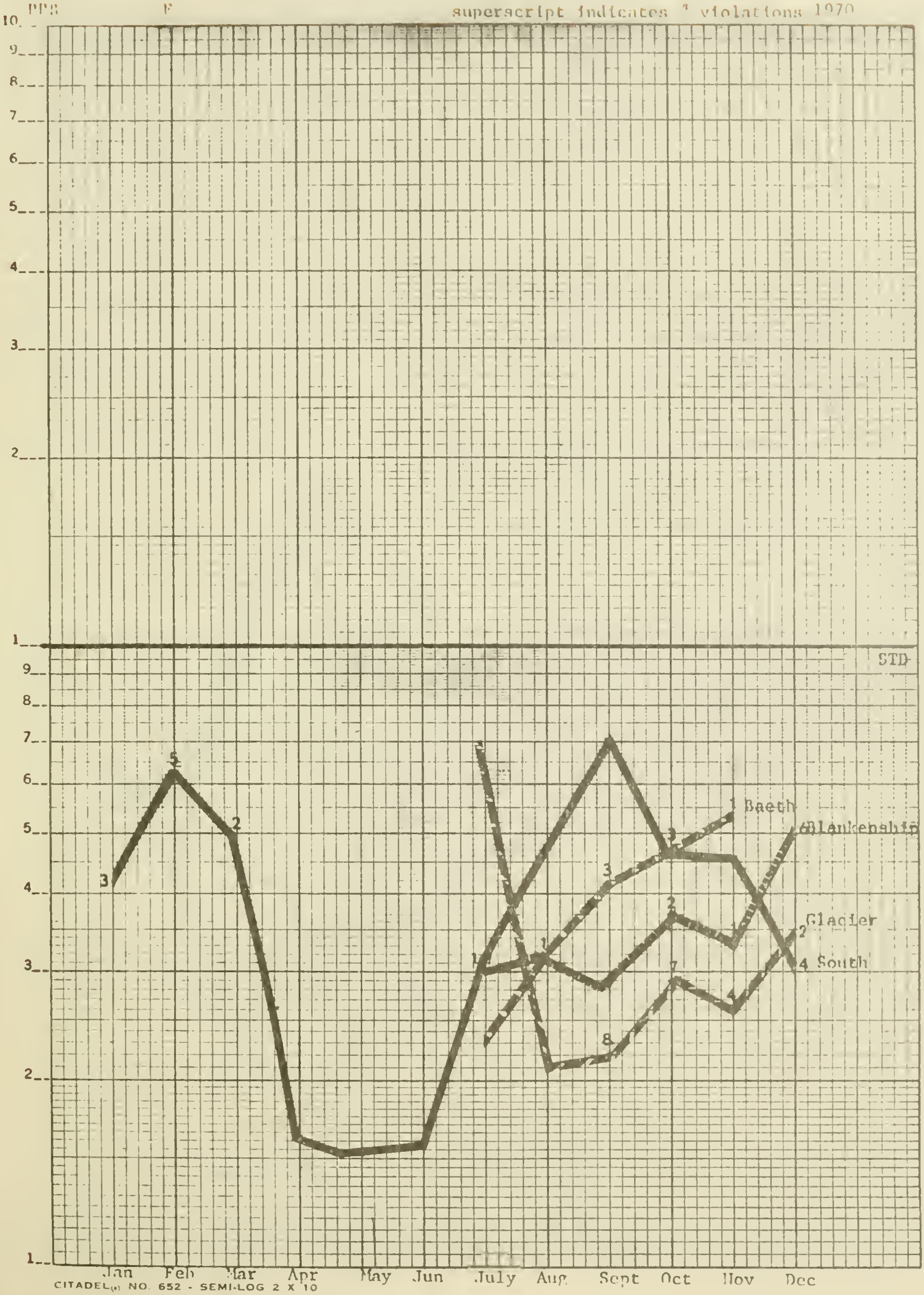
superscript indicates # of violations

AA DATA

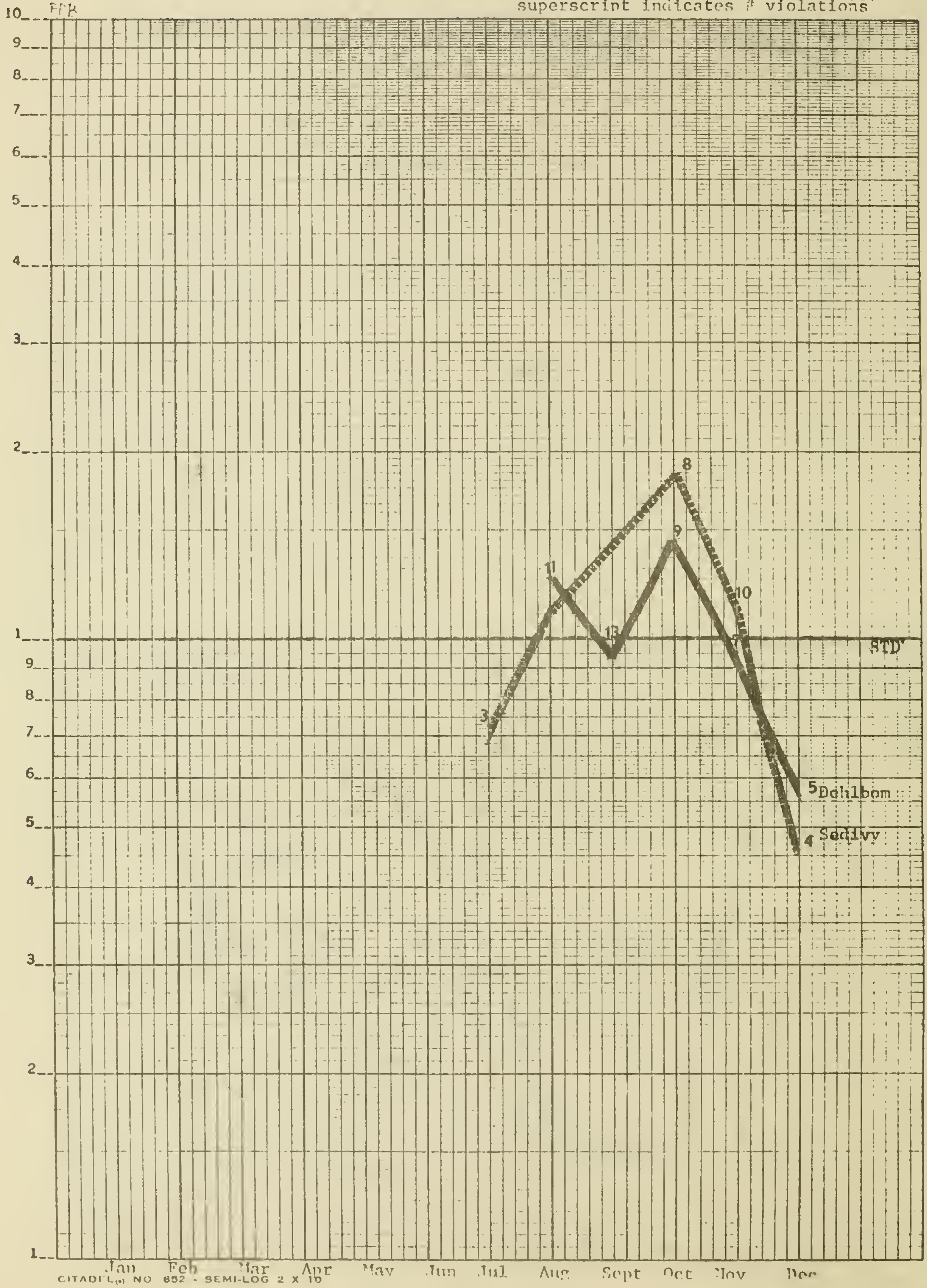


APPENDIX E
AMBIENT SAMPLING--AAC DATA

SODIUM BICARBONATE TUBES AA



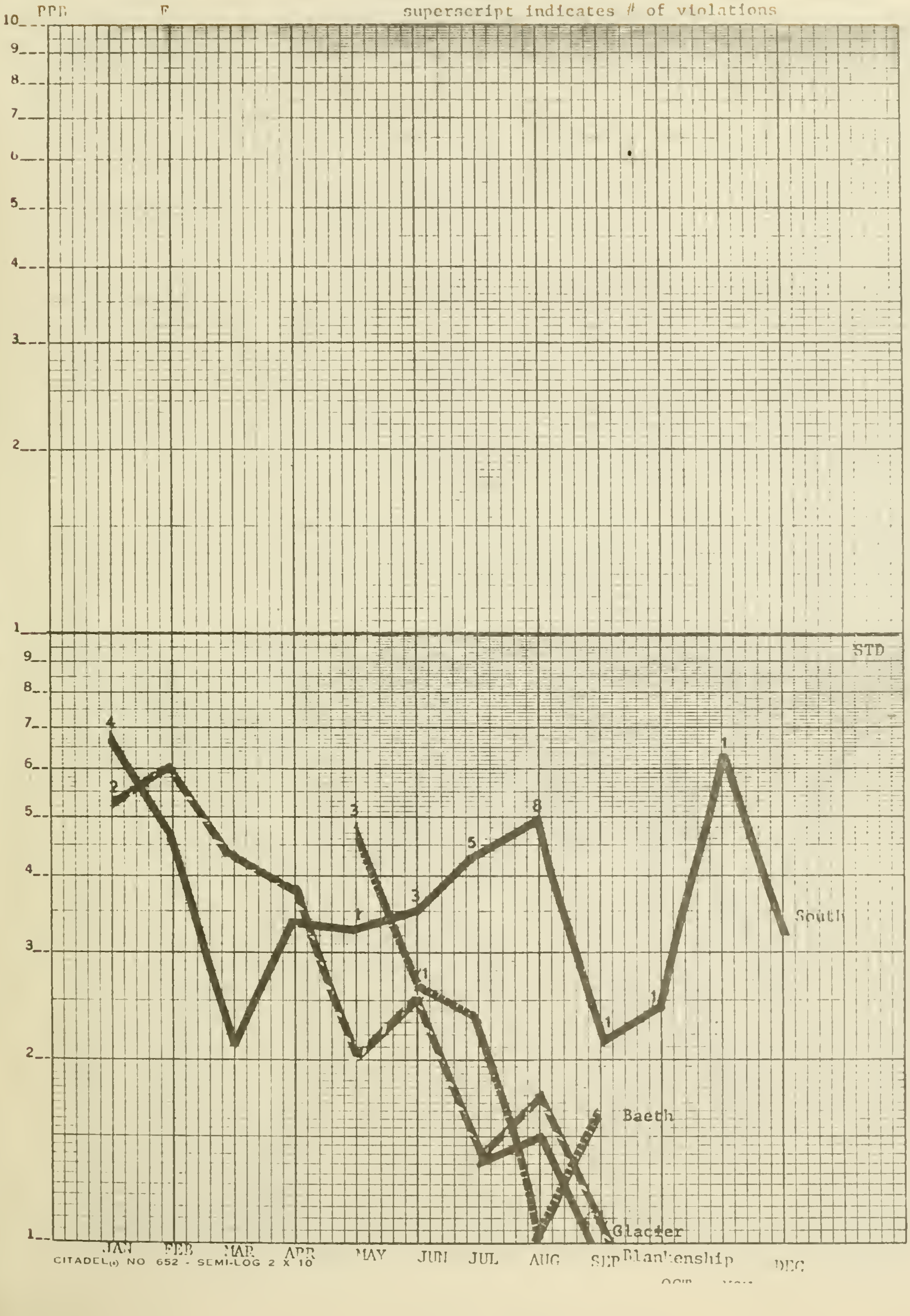
F SODIUM BICARBONATE TUBES AA 1970



superscript indicates # violations

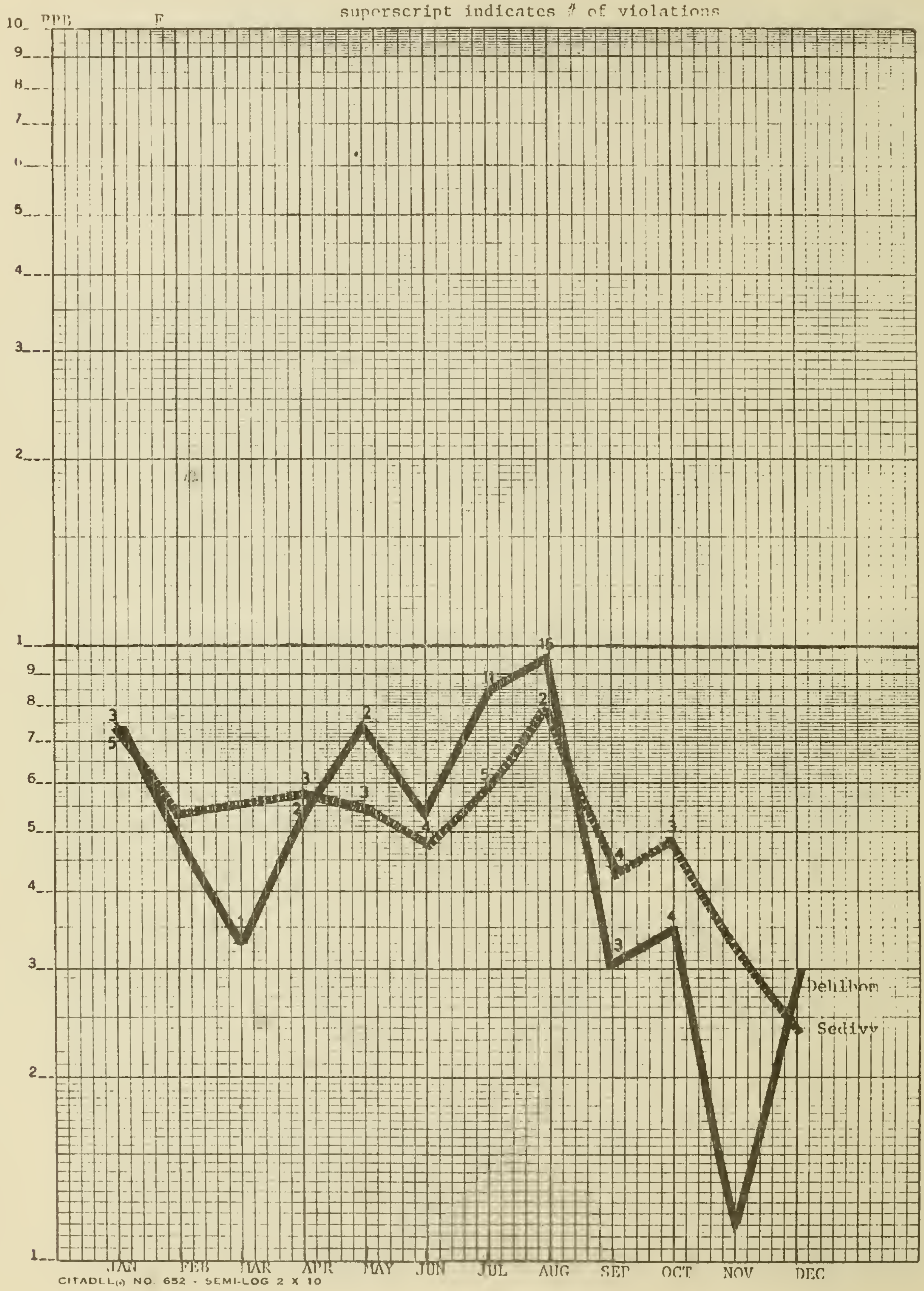
SODIUM BICARBONATE TUBES AA 1971

superscript indicates # of violations



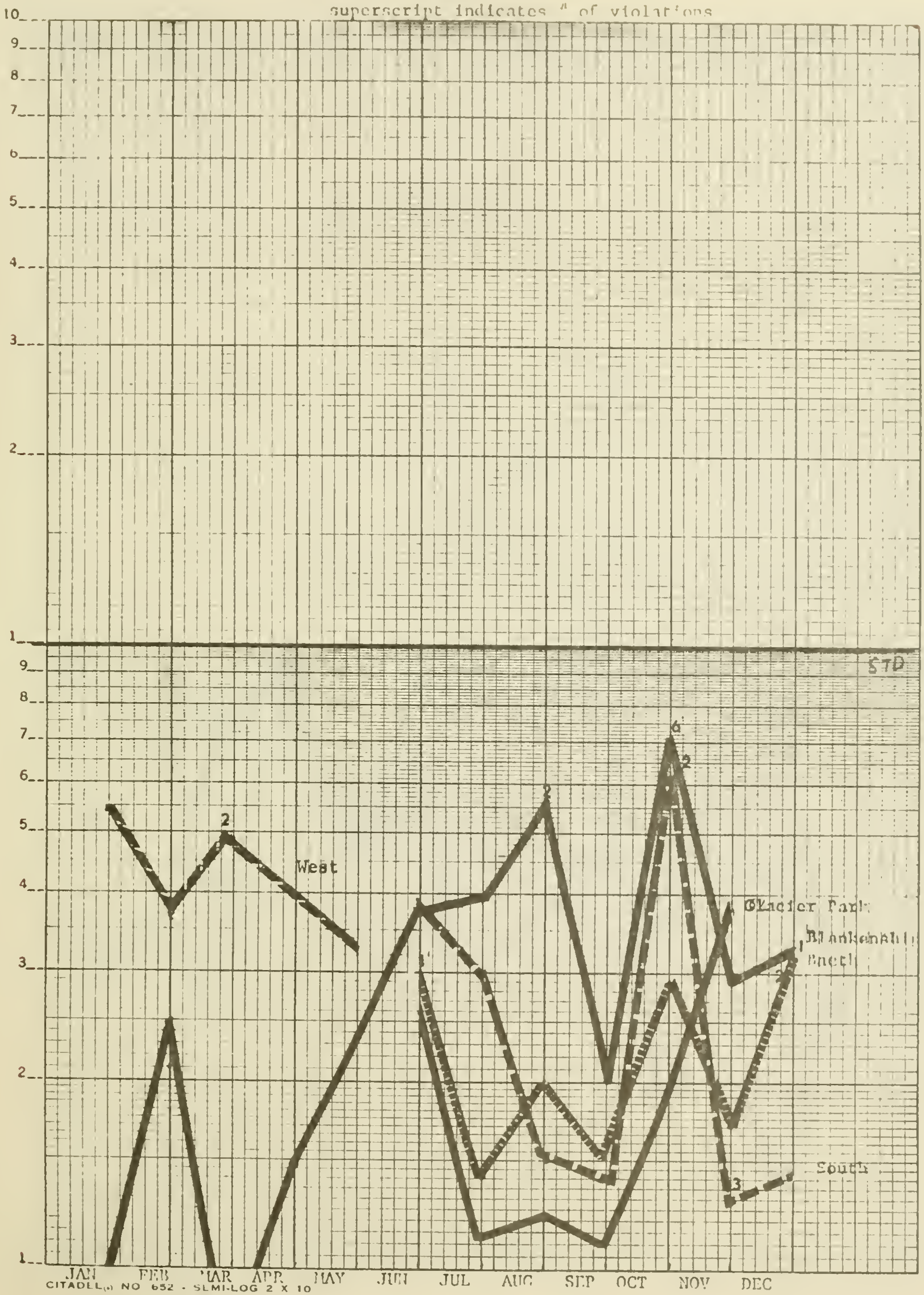
SODIUM BICARBONATE TUBES AA 1971

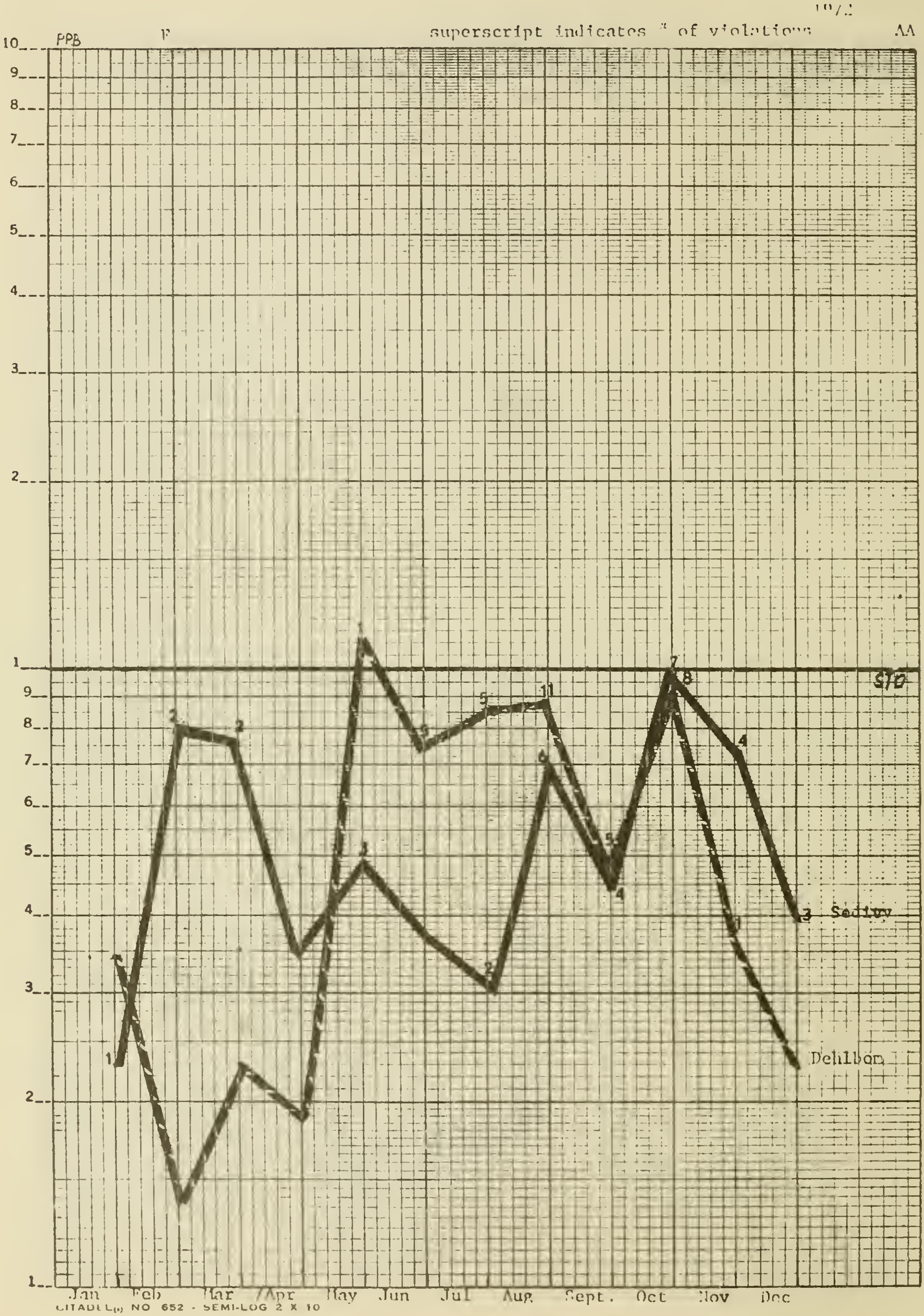
superscript indicates # of violations



F SODIUM BICARBONATE TUBES AA 1972

superscript indicates # of violations




10/2
PPB
F
superscript indicates # of violations
AA
10
9
8
7
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5
4
3
2
1
9
8
7
6
5
4
3
2
1
STD
Sedlov
Dehlbon
1
2
2
1
3
5
5
11
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Jan
Feb
Mar
Apr
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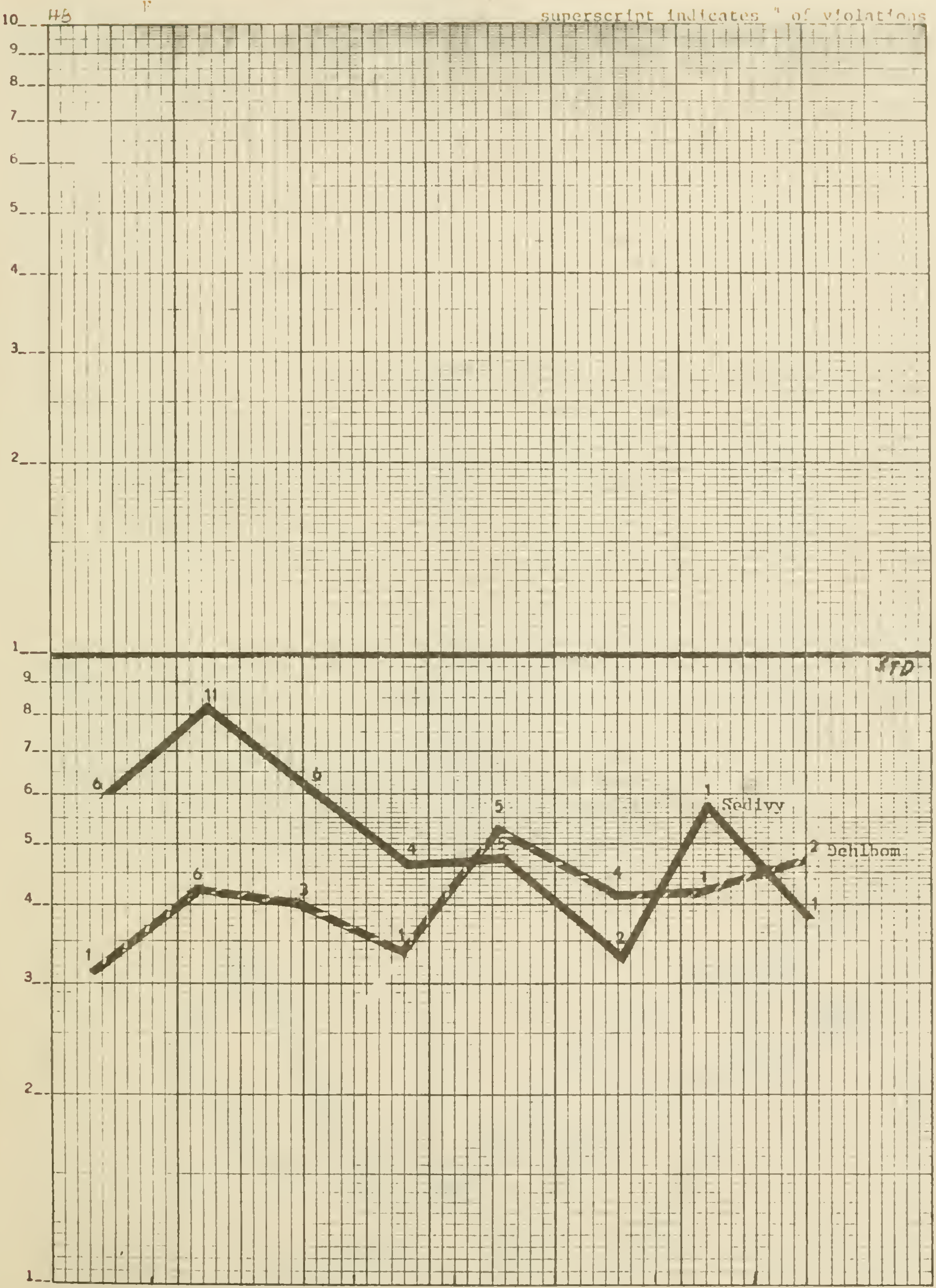
Sept.
Oct
Nov
Dec
CITADEL NO 652 - SEMI-LOG 2 X 10

SODIUM BICARBONATE TESTS 1973

superscript indicates # of violations



CITADEL(R) NO 652 - SEMI-LOG 2 X 10

F SODIUM BICARBONATE TUBES AA 1973

superscript indicates # of violations